THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE III. VOL. VI.

No. IV.—APRIL, 1889.

ORIGINAL ARTICLES.

I.—Some Additions to the Vertebrate Fauna of the Norfolk "Preglacial Forest Bed" with Description of a New Species of Deer (*Cervus rectus*).

By E. T. Newton, F.G.S., F.Z.S.

(PLATE V.)

VERTEBRATE remains from the "Forest Bed" continue to be brought to light by the rapid denudation of the East Anglian coast, and I have again to acknowledge my indebtedness to Mr. A. Savin. of Cromer, whose assiduous collecting has preserved so many of these fossils, and made them available for scientific study. One of the specimens which he has now sent me is a species of *Cervus*, apparently new to science, while the others, although referable to living forms, are now for the first time definitely recorded from the "Forest Bed," and if my determinations prove to be correct, the following names may be added to the list of Mammalia from this deposit:—

Cervus rectus, new species.
Bison bonasus, Linn., var. *priscus*, Bojanus
(to replace *Bos primigenius*).
Phoca barbata, Fabricius.
Delphinapterus leucus, Pallas.
Phocæna communis, Lesson.

Cervus rectus, new species. Plate V. Figs. 1, 1*a*.

One of the most interesting specimens recently discovered in the Cromer "Forest Bed" is a small cervine antler from Sidestrand, attached to the frontal bone by a long pedicle, which reminds one of the recent Muntjac; the form is new to these deposits and, apparently, is an undescribed species.

The frontal suture has been broken away, and consequently the real width of the frontal is uncertain; it is now about 29 mm., and, when perfect, could scarcely have been more than 33 mm.; so that the entire width across the two frontals, just above the orbit and including the bases of the pedicles, could not have been more than 66 mm. (a little more than $2\frac{1}{2}$ inches).

The pedicle is nearly round, where it is free above the frontal, and has a circumference of 58 mm.; seen from the front it is nearly vertical upon the skull, having but a slight divergence; while in a side view, it is so oblique to the frontal as to extend a long way

down the face of the skull; being still prominent so far as the specimen extends, and forming at its lower part a distinct angle in front and another at the outer side, with a flattened space between. At the back the pedicle is about 30 mm. long: in front, about 60 mm. About 70 mm. of the beam are preserved, including the burr, the latter being rugose, irregular and ill-defined. Above the burr, the beam is laterally compressed, and is set somewhat obliquely upon the pedicle, so that from the front it is seen to diverge more from its fellow than does the pedicle itself.

The length of the pedicle, as well as the manner in which it is set on the skull, is quite unlike anything hitherto described from the "Forest Bed series," or indeed from any other British Pliocene or Pleistocene deposit. The simple character of the antler at once suggests the possibility of its having belonged to a young animal, perhaps, the first antler developed. If this be the correct interpretation I am still unable to find any species which, in its early stages, would be likely to have similar pedicles.

The young Roebuck has at first a somewhat similar simple antler, but not flattened, and the pedicle is shorter and differently set on the skull. The nearly allied *Cervus cusanus* (Croizet and Jobert, pl. viii. fig. 1) also has a much shorter pedicle. *Cervus anoceros* (Kaup, Oss. Foss. Mam. 1832–9, pl. xxiv. fig. 2), which with *C. trigonoceros* is now included in the one species *C. dicranoceros*, has a pedicle much longer than this Forest Bed specimen, besides having the antler bifurcate. *Cervus* (*Prox*) *furcatus* as figured by Rütimeyer (Naturliche Geschichte der Hirsche, Abh. Schweiz. Pal. Ges. vol. vii. 1870) also has a much longer pedicle and a bifurcated antler.

As this "Forest Bed" specimen cannot be referred to any known species, and appears to be a new form, it is well that it should have a distinctive name; I propose, therefore, in accordance with the upright character of the antler, that it should be called *Cervus rectus*.

Bison bonasus, Linn., var. *priscus*, Bojanus.

At the time when the Survey Memoir on the "Forest Bed" Vertebrata was published (1882) much doubt was expressed (p. 42) as to whether the bovine remains then known should be referred to *Bos* or *Bison*.

I am now able to speak with certainty as to the occurrence of Bison in these deposits. Mr. Randal Johnson obtained at Bacton and Happisburgh several horn-cores with frontals, undoubtedly belonging to Bison, which are now preserved in Mr. J. J. Colman's collection at Corton, and their "Forest Bed" origin seems to be attested by their mineral condition. Mr. Savin is also in possession of three examples of Bison, undoubtedly from the "Forest Bed."

The first of Mr. Savin's specimens is a much crushed horn-core with part of the skull, from the Iron-pan of the "Forest Bed" at Sidestrand. The condition of the specimen and the place where it was found leave no doubt as to its age, and, although much crushed, the unmistakable extension of the skull behind the base of the horn-core shows that it belongs to *Bison* and not to *Bos*.

The second specimen is from the "Forest Bed" of Trimingham; it consists of a pair of horn-cores from which the skull has been broken away; they are slender and more curved than in most fossil examples of the Bison; but a portion of the skull, still attached to one of the cores, shows that they were placed a little forward from the back, and consequently must be referred to *Bison*.

The third specimen is a fine large horn-core from the "Forest Bed" of Overstrand. There is not sufficient of the skull left to show its characteristic extension behind the horn-core; but it is evidently that of a Bison; being very thick and compressed at its base, where its circumference is 340 mm., and comparatively short, its length, measured along the convex surface, being 390 mm.

There can be no question as to the reference of these specimens to the genus *Bison*, and as there is no good reason for supposing that they are other than the well-known Pleistocene species, they are placed with *Bison priscus*, or rather, to use the corrected nomenclature, *Bison bonasus*, var. *priscus*.

Having then undoubted evidence of the occurrence of *Bison* in the Cromer "Forest Bed," and as all the bovine specimens hitherto found may belong to that genus, it will be necessary to remove the genus *Bos* from the lists of "Forest Bed" mammals, until there is definite proof that both forms existed.

Phoca (*Erignathus*) *barbata*, Fabricius (Bearded Seal). Pl. V. Figs. 2, 2*a*.

The genus *Phoca* has already been recorded from the Cromer "Forest Bed" (Survey Memoir, p. 29); but the specimens known did not allow of specific identification, although it was thought they might belong to *Phoca vitulina*. Mr. Savin now possesses a very fine characteristic humerus of a large Seal from Overstrand, near Cromer.

The deltoid crest as well as the proximal and distal tuberosities are somewhat broken, so much of the latter being lost that only a trace of the supra-condylar foramen remains. In spite of these defects, however, there can be no question as to the form of the bone. The deltoid crest is strongly developed and extends half-way down the bone, its outer side having a well-marked depression. The shaft is laterally compressed; the upper part of the back is rounded, but lower down there is a ridge, which passing outwards is continuous with the outer or supinator ridge. A smooth space on the inner side a little above the distal articulation shows the position of the supra-condylar foramen. The principal measurements of the bone are:—greatest length, 143 mm. (5·55 inches); short diameter of middle of shaft, 19 mm.; length of deltoid crest, 76 mm.; diameter of head, 30 mm.

On comparing this humerus with those of the Seals in the Royal College of Surgeons and in the British Museum, I find it differs in certain important points from all but one of them, namely, *Phoca barbata*, and with this it agrees so exactly in every particular, except in being a trifle smaller, that I have no hesitation in referring the fossil to the same species.

Phoca barbata is found living at the present day in the more northern parts of the Atlantic and in the Arctic Seas. Although the species has been recorded as British, yet, according to Bell (British Quadrupeds, second edition, 1874, p. 238), it seems to be very doubtful whether the species has ever been found living on the coasts of Britain. The skeleton in the British Museum is said to have come from the North Sea.

Monodon monoceros, Linn. (Narwhal).

The occurrence of the Narwhal in the "Forest Bed" was noted in the Survey Memoir, a portion of a tusk in the Norwich Museum having been identified. It is satisfactory, however, to be able to confirm this identification by a specimen of peculiar interest from the "Forest Bed" of Overstrand, near Cromer, now in the possession of Mr. Savin. It is well known that the male Narwhal has, as a rule, only one large tusk developed, and this on the left side; the right one being aborted and so small as to be entirely buried in the bones of the snout. Mr. Savin's specimen is a portion of the right side of a Narwhal's skull, which having been broken open, shows the hinder half of the aborted tusk *in situ*. This portion of tusk is 140 mm. in length and 25 mm. in diameter. The hinder end is curved inwards, as in some recent specimens, and the pulp cavity is entirely obliterated by a deposit of irregular dentine, which forms a globose mass at the base of the tusk.

Delphinapterus leucus, Pallas (Beluga, or White Whale). Plate V. Figs. 3, 3*a*.

To this genus and species is referred a fifth or sixth caudal vertebra from the "Forest Bed" of East Runton, which is more nearly perfect than most of the Cetacean vertebræ from these beds. The terminal epiphyses are wanting and the ends of the transverse processes are somewhat broken, but the forms of the centrum and neural arch are well preserved. The greatest height of the specimen, including as much of the neural spine as is present, is 113 mm.; the front surface of the centrum is slightly hollow and shows distinctly the radiating ridges from which the epiphysis has separated; it is about 76 mm. high and 68 mm. wide. The hinder surface is slightly convex and is rather smaller than the front. The greatest length of the centrum, in its present condition, is about 55 mm., so that with its epiphyses its length must have been nearly if not quite equal to its width.

The transverse processes are a little below the middle of the centrum, and their bases, or rather the sides of the centrum at their bases, are each pierced vertically by a large vascular canal, which is rather nearer the back than the front of the centrum. Immediately below the lower opening of each of these canals is another which passes obliquely through the lower part of the centrum and enters the hæmal groove, seen on the lower surface of the specimen.

Having compared this vertebra with the specimens in the Royal College of Surgeons and in the British Museum, I find it to be

larger than the corresponding one in *Tursiops tursio*; but smaller than that of *Globicephalus melas*, *Pseudorca* or *Monodon*. It agrees, however, so nearly in size and shape with the fifth or sixth caudal vertebra of the White Whale (*Delphinapterus leucus*), that I feel justified in placing it in that species.

Mr. Savin has another vertebra from the "Forest Bed" of Overstrand which, although much damaged, is evidently from the lumbar region, and has on the under surface two distinct, oblique grooves, similar to those seen in the White Whale; but which I have been unable to find in any other Cetacean skeleton of a corresponding size. This vertebra is also referred to *D. leucus*.

A Cetacean vertebra in the Owles collection, British Museum (No. 46,290) dredged in the North Sea has been placed in this species by Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus. part v. p. 79), but this is probably of more recent origin, as pointed out by my friend Mr. W. Davies (Geol. Mag. Dec. II. Vol. V. p. 97, 1878).

At the present day the White Whale is an inhabitant of the Arctic seas, although it has occasionally been met with on the north British coasts.

Phocæna communis, Lesson (Porpoise). Plate V. Figs. 4, 4*a*.

I have now to call attention to a caudal vertebra of a small Cetacean from the "Forest Bed" of Sidestrand. It is of similar size to that of the Dolphin, a species already recorded from these beds, but its proportions are different. The neural arch and transverse processes are broken away; but the epiphyses are firmly united and the sutures obliterated. The vertical vascular canals pass through the bases of the transverse processes, and are similar to those of the caudal vertebra of the White Whale described above. The faces of the centrum are nearly round and flat, with only a slight concavity in the middle; the height and width being each about 36 mm., while the length of the centrum is about 33 mm. or nearly equal to the width. This proportion of length to width is quite unlike what is found in the Dolphin, but agrees with that seen in the Porpoise; and indeed the agreement of this specimen with the fifth or sixth caudal vertebra of *Phocæna communis* is sufficient to justify its reference to that species.

The Porpoise is now living in the North Atlantic and is common around the coasts of Great Britain.

EXPLANATION OF PLATE V.

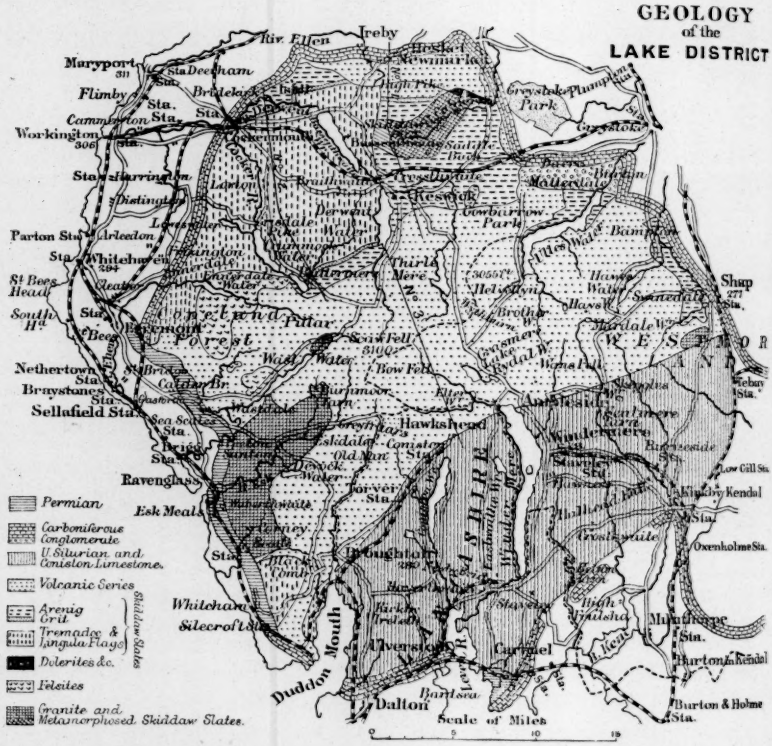
All specimens from the "Forest Bed Series" and in Mr. Savin's Collection at Cromer.

Fig. 1. *Cervus rectus*, n. sp. Right antler and frontal, from Sidestrand; front view.
Fig. 1*a*. *Cervus rectus*, side view.
Fig. 1*b*. Section of antler.
Fig. 2. *Phoca barbata*, Fabricius, Left humerus, from Overstrand, inner side.
Fig. 2*a*. *Phoca barbata*, front view.
Fig. 3. *Delphinapterus leucus*, Pallas. Caudal vertebra (5th or 6th), from East Runton; side view.
Fig. 3*a*. *Delphinapterus leucus*, front view.
Fig. 4. *Phocæna communis*, Lesson. Caudal vertebra (5th or 6th), from Sidestrand; side view.
Fig. 4*a*. *Phocæna communis*, front view.

II.—On the Superimposed Drainage of the English Lake District.

By J. E. Marr, M.A., Sec. G.S.

"WHAT was the condition of our present mountain tract during the great Carboniferous period? Was it wholly submerged after the elevation and denudation to which we have already seen it subject, or was there always a nucleus of dry land—an embryo of Cumbria—around which the Carboniferous deposits were laid down? I do not think this is a question that can ever be decidedly answered." [1]



It is a question which has frequently been asked, and the answers given are various. In the present communication I intend to look at it from a somewhat different point of view from that in which it has usually been approached, though the view here adopted in many respects resembles that taken by the late Mr. Hopkins.[2] The exact

[1] On the Physical History of the English Lake District, by the Rev. J. C. Ward. Geol. Mag. Dec. II. Vol. VI. p. 58.

[2] On the Elevation and Denudation of the District of the Lakes of Cumberland and Westmoreland, Q. J. G. S. vol. iv. p. 70.

influence which the faults have had in determining the trend of the major valleys is however of little importance to my present inquiry.

§ 1.—*Structure of the District.*

The well-known general structure of the district is seen in the sketch-map, which exhibits the Lower Palæozoic rocks nearly surrounded on every side by a girdle of Carboniferous Limestone, the strike of which is always approximately parallel to the line of demarcation between the older and newer rocks, the former rising up as an irregular dome within the latter. Whereas the main axis of the older rocks *within the district* runs through the Skiddaw group of hills, the present watershed is marked by an east and west line running through the Scawfell group across Kirkstone, and the passes at the heads of the Kentmere and Long Sleddale valleys to Shap Wells, whence it is continued in an easterly direction over ground occupied by Carboniferous rocks, separating the head-waters of the rivers Eden and Lune.

§ 2.—*Condition of the area at the commencement of Carboniferous times.*

Mr. Hopkins pointed out that the dip of the Carboniferous rocks was everywhere sufficient to carry them far above the present surface of the older rocks in the central part of the district, and he gives cogent reasons for supposing that they actually did so extend. As it is of the utmost importance that this point should be definitely settled, I propose here to give further arguments in favour of the submergence of the whole of the Lower Palæozoic area during Carboniferous times, and to show that the present drainage was certainly not impressed upon the district in pre-Carboniferous days.

The very uniform plain of denudation upon which the Carboniferous rocks were laid down in the Ingleborough region is well known, but those who maintain the existence of a pre-Carboniferous ridge over the area of the present Lake District require the cessation of this plain towards the west. But MM. de Koninck and Lohest[1] show that the Lower Carboniferous beds of Belgium are represented by the conglomerate of the Ingleborough district, and it is probable that beds quite as low occur in the immediate proximity of the Lake District, though this point will be definitely settled when Mr. E. J. Garwood, B.A., who is now engaged in a detailed examination of the Carboniferous zones of the region has published his researches. If the Lake District area had stood out as an elevation at this period, the equivalents of the lowest strata of Ingleborough should be absent here. Not only does the Mountain Limestone form a nearly complete ring round the lakes, but at one point where the ring is broken by the complex group of faults uniting the Craven and Pennine fractures, great masses of the limestone are let down into the dome, as at Grey Rigg and Kendal, indicating that the limestone at any rate extended thus far.

Again, the folding of the Lower Palæozoic rocks would not give

[1] Notice sur le Parellélisme entre le calcaire Carbonifère du nord-ouest de l'Angleterre et celui de la Belgique, Bulletins de l'Académie royale de Belgique, 3me. série, t. xi. no. 6.

rise to a ridge along the present line of watershed of the Lake District, but along the centre of the anticline, though there may have been higher ridges of older rock existing to the north of the Skiddaw axis, which determined the trend of the pre-Carboniferous valleys, and that this was the case is indicated by an examination of the mode of occurrence of the irregular patches of the basal Carboniferous conglomerate, and a study of their included pebbles. These conglomerates, from their extremely local distribution, are generally and probably rightly supposed to have been deposited in the troughs of inequalities, though there is some doubt as to the region from which the material was brought. Mr. Clifton Ward, in the paper cited, comments upon the close similarity between the pebbles of the Mell Fell conglomerate to the rocks forming the Ludlow beds of the Kendal district, and the great rarity of local rocks in the conglomerate. I have recently detected a pebble in the same conglomerate at Roman Fell near Appleby, containing a fossil which appears to be *Rhynchonella nucula*, a characteristic Ludlow form. But, that these pebbles came from the south is unlikely for the reason to be noted immediately, and similar rocks occur in the southern uplands of Scotland on the south side of what probably constituted a pre-Carboniferous mountain axis, so that the drainage may well have come from this direction. Prof. Hughes has detected in the same conglomerates in the Lune Valley, pebbles of the well-known Keisley limestone of Appleby, a peculiar and easily recognizable rock, which is developed in this form in no other part of the district, and which, for reasons which cannot be here given, is unlikely to occur elsewhere. This discovery indicates a drainage on the pre-Carboniferous slopes in a southerly direction, and suggests a northern source for the pebbles of the conglomerate. Now Keisley is separated from the Lune Valley by a continuation of the main watershed of the Lake District, so that at the time of the formation of the conglomerate, if the pebbles of the Lune Valley have actually come from Keisley, *the present watershed did not exist*, and indeed the way in which the Carboniferous rocks rise from Tebay to Shap Wells, and then sink to the Eden Valley, proves that this elevation was post-Carboniferous.

Recent discoveries, it will be seen, fully confirm Mr. Hopkins's conclusion that the Carboniferous rocks were laid down over the area of the present Lake District upon an even horizontal surface.

§ 3.—*Post-Carboniferous Changes. Formation of the Dome, and Determination of the Drainage.*

The examination of the area has shown, what would be *a priori* expected, that the pre-Carboniferous drainage was not determined by the more modern Lower Palæozoic rocks of the district, and these could be converted into the highest ground of the region by no other means than a further upthrust, which took place in post-Carboniferous times. Even then, the drainage would not radiate from an area of Lower Palæozoic rocks, unless these rose above the surrounding high ground caused by the accumulation of the up-

heaved newer sediments, and the thickness of the latter in the immediate proximity to the centre of the district forbids the supposition that a high mountain tract over which Carboniferous rocks were never deposited arose in that centre. If we prolong the Carboniferous rocks over the present area in accordance with their various dips at the margins, we shall find that *the centre of the dome composed of these rocks would coincide with the small tract from which the principal valleys radiate*, viz. the region of Scawfell and Gable. The appearance of the eight principal valleys extending from this point, like the spokes of a wheel, is beautifully described by Wordsworth.[1] They are Windermere, Coniston, Duddon, Eskdale, Wastdale, Ennerdale, the Vale of the Cocker, and Borrowdale. Further to the east the symmetry of the dome is destroyed by its prolongation in an easterly direction as an anticlinal (though even here the Carboniferous beds dip eastward on the summit of the anticlinal axis, showing that the district does not merely comprise the end of an anticline), and by the proximity of the great faults of the Lune Valley. Here, also, the radial character of the valleys is noticeable. To the north of the axis are the vales of Thirlmere, Ulleswater, and Haweswater, and to the south, those of Kentmere, Long Sleddale, Crookdale, Bannisdale, and Wastdale. This radial arrangement is well exhibited in the case of the valleys containing the larger lakes, on examining the small map. The valleys do not in all cases coincide with the observed or theoretical faults shown by Mr. Hopkins upon his map, though the general direction is the same.

The radiating disposition of the vales could not have been determined except by a somewhat regular dome-shaped upheaval of the country, and the trend of the Lower Palæozoic rocks shows no tendency towards the formation of a dome in them before the deposition of the Carboniferous rocks, whereas, as has been above noted, the dips of the Carboniferous rocks do point to the production of a post-Carboniferous dome, whose centre coincides with the point from which the valleys diverge. The drainage system is, in fact, strikingly similar to that represented by Mr. Gilbert in the case of the Ellsworth Arch,[2] even to the slight irregularity which occurs at the north end of the latter, owing to the proximity of Mounts Holmes and Hillers, and at the east end of the Lake District owing to the anticline separating the Lune and Eden Valleys, and the faults of the Lune Valley.

It is hard to resist the conclusion that in the Lake District, as in the Henry Mountains, we have a case of *superimposed drainage*, the valleys having had their direction determined by the slopes caused by the upheaval of the Carboniferous and possibly of newer rocks, though they now run in the centre of the district entirely through Lower Palæozoic rocks, the newer rocks which were the cause of their present trends having been completely removed by denudation.

This seems to me the strongest argument in favour of the former

[1] A Complete Guide to the Lakes, third edition, page 111.

[2] Geology of the Henry Mountains, p. 139, fig. 71.

extension of the Carboniferous rocks over the district, and the study of the valley-systems of other areas will probably enable us in many cases to argue concerning the former extension of beds over regions from which they have long since disappeared.

The duration of the movement which caused the elevation of the dome is hard to determine. There is no doubt that elevation had taken place before the deposition of the New Red Sandstone deposits of Edenside and the Cumbrian coast, for the latter rest unconformably upon the Lower Palæozoic rocks in places, and the former contain fragments of Mountain Limestone, whilst the sandstones were probably derived in great part from the denudation of the Carboniferous sandstones. In connexion with this point the rarity or absence of Lower Palæozoic pebbles in the New Red breccias of Edenside is noticeable, and has been commented upon by Mr. Goodchild.[1] It furnishes another argument in favour of the extension of the Carboniferous rocks over the central part of the district. But that the elevation was entirely carried on during the time that elapsed between Carboniferous and New Red Sandstone times is negatived by the dip of the New Red itself, which, as observed by Mr. Hopkins and Mr. Goodchild, is sufficient to carry these deposits also over the central dome. Now, the north-east portion of the Lake District dome coincides with the western margin of the New Red basin of Edenside, and was therefore partly determined simultaneously with the latter.

The New Red Sandstones were apparently deposited in a fjord-like indentation produced during the deposition of these rocks (a point which is well worth working out in detail by any one who has carefully studied the characters and distribution of these rocks). But there appears to be no important physical break between the New Red deposits of Edenside and the lowest Jurassic beds of Carlisle. The position of the latter indicates that they also were deposited during the continuance of the formation of the basin, and there is no reason why these and newer Mesozoic rocks should not have once extended over the gradually rising dome of the Lake District. If this be so, the valleys of the district need not date back to any very remote period, and may even have been commenced in Tertiary times.

§ 4.—*Origin of the Dome.*

It has been observed, that although the Lake District dome is a continuation westward of an anticlinal axis, it is, nevertheless, in a certain sense distinct from this axis. Not only is this the case, but it will be noticed, on examining a geological map of England, that the dome causes a marked asymmetry in the arrangement of the Carboniferous rocks.

The north and south Pennine axis, and the east and west axis separating the coal-field of Yorkshire, Derbyshire, and Nottinghamshire from that of Newcastle, and that of South Lancashire and North Staffordshire from that of Cumberland, give rise to a cruciform

[1] Trans. Cumb. and West. Assoc. 1885, p. 37.

arrangement of the coal-fields, but the north-west part of the cross is interfered with by the Lake District dome, and hence the Cambrian coal-field is of small dimensions as compared with that of Newcastle. Whilst the widespread movements which caused this cruciform arrangement were proceeding, a local movement has produced the asymmetry of the north-west portion. To what is this local movement due? Can the comparison with the laccolitic structure be carried further, and may we suppose that a lenticle of igneous rock lies at some depth below the Lower Palæozoic rocks of the Lake District? The evidence on this point is wanting. Most of the igneous rocks which penetrate the Lake District slates appear to have been intruded before the formation of the Carboniferous deposits, and the latter are remarkably free from igneous intrusions. Those which do occur are of a basic character.

The existence of the Whin Till indicates the occurrence of large masses of basic rock at a lower level, and it might be compared with one of the outlying sheets of the Henry Mountain laccolites. But the position of the igneous masses with which it is connected are not easy to fix, and the rocks of the Lake District and the surrounding area do not exhibit the abundance of basic dykes which one would expect in the vicinity of a laccolitic mass. There are a few dykes in the Carboniferous rocks of the Whitehaven district and near Ulleswater, and another dyke pointing to the Lake District is mapped by the geological surveyors in the Carboniferous rocks of Caton Green near Lancaster. Near the centre of the dome are several radial and tangential basic dykes, as seen in the geological map of the country around Wastwater, and these dykes are newer than the numerous acid dykes which cut through the same rocks, for they displace them. We may be allowed, then, to suggest the possibility of a mass of basic rock underlying and connected with the formation of the Lake District dome, without in any way insisting upon its probability.

Be this as it may, the superimposed drainage of the Lake District appears to be an actual fact, and the occurrence of this is an interesting point in the fascinating study of the physical history of this beautiful and remarkable area.

III.—The Work of Prof. Henry Carvill Lewis in Glacial Geology.

By Warren Upham, of the United States Geological Survey.

THE recent notice[1] of the life and work of Prof. Henry Carvill Lewis, whose lamented death occurred in Manchester, July 21st, 1888, in his thirty-fifth year, well indicates the wide range of his scientific labours. He published valuable results of investigations in astronomy, mineralogy and petrology, and especially in glacial geology, the last being based on his exploration of the drift

[1] This Magazine, III. Vol. V. pp. 428–430, September, 1888. A similar but more extended notice, with portrait, appeared in the American Geologist for December, 1888.

and its terminal moraines in the United States, and later in Ireland, Wales and England. The present article reviews his contributions to our knowledge of these drift formations and of the history of the Ice Age, bringing into comparison and correlation the glacial records of America and Europe. Comprehensive as were Professor Lewis' observations and studies in this field, he was planning yet more thorough and extensive exploration of the drift in Britain, Germany and Scandinavia, when he was taken from us. In his death the geologists of two continents mourn the loss of a most gifted and faithful fellow-worker, who indeed already had achieved a grand life-work in the few years allotted to him.

Professor Lewis first became specially interested in the glacial drift and the terminal moraine of the North American ice-sheet during the later part of the year 1880, when in company with Prof. G. F. Wright he studied the remarkable osars of Andover, Mass., the gravel of Trenton, N.J., containing palæolithic implements, the drift deposits of the vicinity of New Haven, Conn., under the guidance of Professor Dana, and finally the terminal moraine in Eastern Pennsylvania, between the Delaware and Lehigh rivers. The following year Professors Lewis and Wright traversed together the southern border of the drift through Pennsylvania, from Belvidere on the Delaware west-north-west more than 200 miles across the ridges of the Alleghanies to Little Valley, near Salamanca, N.Y., and thence south-westerly 130 miles to the line dividing Pennsylvania and Ohio, which it crosses about fifteen miles north of the Ohio river. The report of this survey of the terminal moraine was published in 1884, forming volume Z of the Reports of Progress of the Second Geological Survey of Pennsylvania. With the similar exploration of other portions of this great moraine done a few years earlier by Prof. Chamberlin in Wisconsin, Profs. Cook and Smock in New Jersey, and the present writer in Long Island, thence eastward to Nantucket and Cape Cod, and also in Minnesota, it completed the demonstration of the formation of the North American drift by the agency of land-ice.

The observations of the moraine in Pennsylvania detailed in this volume are summarized by Prof. Lewis as follows:—"The line separating the glaciated from the non-glaciated regions is defined by a remarkable accumulation of unstratified drift material and boulders, which, heaped up into irregular hills and hollows over a strip of ground nearly a mile in width, forms a continuous line of drift hills (more or less marked) extending completely across the State. These hills vary in height from a few feet up to 100 or 200 feet; and while in some places they are marked merely by an unusual collection of large transported boulders, at other places an immense accumulation forms a noteworthy feature of the landscape. When typically developed this accumulation is characterized by peculiar contours of its own,—a series of *hummocks*, or low conical hills, alternate short straight ridges, and inclosed shallow basin-shaped depressions, which like inverted *hummocks* in shape are known as *kettle holes*. Large boulders are scattered over the surface; and the unstratified *till*

which composes the deposit is filled with glacier-scratched boulders and fragments of all sizes and shapes."

From its lowest point in Pennsylvania, where it crosses the Delaware 250 feet above the sea-level, this terminal moraine of the ice-sheet extends indiscriminately across hills, mountains and valleys, rising over 2000 feet above the sea in crossing the Alleghanies, and attaining the maximum of 2580 feet on the high table-land farther west, being there "finely shown at an elevation higher than anywhere else in the United States."

Preliminary outlines of Professor Lewis's work on the glacial drift of England, Wales and Ireland are given in his papers in the Reports of the British Association for 1886 and 1887; and the first of these also appeared in the American Naturalist for November, and the American Journal of Science for December, 1886, and in this MAGAZINE for January, 1887. Their most important new contribution to knowledge consists in the recognition of the terminal moraines formed by the British ice-sheets, which Lewis traced across Southern Ireland from Tralee on the west to the Wicklow Mountains and Bray Head, south-east of Dublin; through the western, southern and south-eastern portions of Wales; northward by Manchester and along the Pennine Chain to the south-east edge of Westmoreland; thence south-easterly to York and again northward nearly to the mouth of the Tees, and thence south-eastward along the high coast of the North Sea to Flamborough Head and the mouth of the Humber. It is a just cause for national pride that two geologists of the United States, Lewis in Great Britain in 1886, and Salisbury[1] the next year in Germany, have been the first to discover the terminal moraines of the ice-sheets of Europe. Like the great moraines of the interior of the United States, those of both England and Germany lie far north of the southern limit of the drift.

Another very important announcement by Professor Lewis relates to the marine shells, mostly in fragments and often worn and striated, found in morainic deposits and associated kames 1100 to 1350 feet above the sea on Three Rock Mountain near Dublin, on Moel Tryfan in Northern Wales, and near Macclesfield in Cheshire, which have been generally considered by British geologists as proof of marine submergence to the depth of at least 1350 feet. These shells and fragments of shells, as Lewis has shown, were transported to their present position by the currents of the confluent ice-sheet which flowed southward from Scotland and Northern Ireland, passing over the bottom of the Irish Sea, there ploughing up its marine deposits and shells, and carrying them upward as glacial drift to these elevations, so that they afford no testimony of the former subsidence of the land. The ample descriptions of the shelly drift of these and other localities of high level, and of the lowlands of Cheshire and Lancashire, recorded by English geologists,[2] agree

[1] American Journal of Science, III. vol. xxxv. pp. 401-407, May, 1888.

[2] Quart. Journ. Geol. Soc. vol. xxx. 1874, pp. 27-42; xxxiv. 1878, pp. 383-397; xxxvi. 1880, pp. 351-5; xxxvii. 1881, pp. 351-69; and xliii. 1887, pp. 73-120; also, GEOL. MAG. Dec. II. Vol. I. 1874, pp. 193-197.

perfectly with the explanation given by Lewis, which indeed had been before suggested, so long ago as in 1874, by Belt and Goodchild.[1] This removes one of the most perplexing questions which glacialists have encountered, for nowhere else in the British Isles is there proof of any such submergence during or since the Glacial period, the maximum known being 510 feet near Airdrie in Lanarkshire, Scotland.[2] At the same time the submergence on the southern coast of England was only from 10 to 60 feet,[3] while no traces of raised beaches or of Pleistocene marine formations above the present sea-level are found in the Shetland and Orkney Islands.[4] The work and writings of Professor Lewis emphasize the principle that glacially transported marine shells and fragments of shells, which occur in both the till and Boulder-clay and the modified drift in various parts of Great Britain, are not to be confounded with shells imbedded where they were living or in raised beaches, for only these prove the former presence of the sea.

The drift deposits of England south of the terminal moraines traced by Lewis were regarded by him as due to floating ice upon a great freshwater lake held on the north by the barrier of the ice-sheet which covered Scotland, Northern England and the area of the North Sea, and on the south-east by a land barrier where the Strait of Dover has been since eroded. Under this view he attributed the formation of the Chalky boulder-clay in East Anglia, and of the Purple and Hessle boulder-clays in Lincolnshire and much of Yorkshire, to lacustrine deposition. But shortly after the British Association meeting in 1887 his observations on Frankley Hill in Worcestershire and thence westward[5] led him to accept the conclusion, so thoroughly worked out by other glacialists both in America and Great Britain, that there were two principal epochs of glaciation, divided by an interglacial epoch when the ice-sheets were mostly melted away. There can be little doubt that the continuation of Lewis's study of the drift in England, if he had lived, would have soon convinced him of the correctness of the opinions of Searles V. Wood, jun., Mr. Skertchly, and James Geikie,[6] that land-ice during the earlier glacial epoch overspread all the area of the Chalky boulder-clay, extending south to the Thames. Small portions of Northern England, however, escaped glaciation both then and during the later cold epoch, when the terminal moraines mapped by Lewis were accumulated; and these tracts of the high moorlands in Eastern Yorkshire and of the eastern flank of the

[1] Nature, vol. x. pp. 25, 26, May 14, 1874; Geol. Mag. Dec. II. Vol. I. pp. 496–510. Nov. 1874. A similar opinion was held fifty years ago by Mr. James Smith (Researches in Newer Pliocene and Post-Tertiary Geology, pp. 11, 16), though he attributed the drift to debacles instead of glaciation.

[2] Quart. Journ. Geol. Soc. vol. vi. 1850, pp. 386–8; xxi. 1865, pp. 219-21.

[3] Quart. Journ. Geol. Soc. vol. xxxiv. 1878, pp. 454-7; xxxix. 1883, p. 54. Geol. Mag. Dec. II. Vol. II. 1875, p. 229; Dec. II. Vol. vi. 1879, pp. 166-72.

[4] Quart. Journ. Geol. Soc. vol. xxxv. 1879, p. 810; xxxvi. 1880, p. 663.

[5] Geol. Mag. Dec. III. Vol. IV. pp. 515-17, Nov. 1887; Vol. V. p. 430, Sept. 1888.

[6] Quart. Journ. Geol. Soc. vol. xxxvi. 1880, pp. 463-500; Great Ice Age, second ed. pp. 350–365.

Pennine Chain[1] are similar to the driftless area of South-western Wisconsin.

Comparison of the drift in North America and Great Britain enabled Prof. Lewis to refer the British modified drift, both that often intercalated between deposits of till and that spread upon the surface in knolly and hilly kames and more evenly in plains and along valleys, to deposition from streams supplied by the glacial melting, the material being washed out of the ice-sheet. These beds are to be carefully distinguished from others, similar to them in condition and material, which are of interglacial and post-glacial age. In this connection it is also important to discriminate between subglacial till or ground moraine and englacial till that was contained in the ice-sheet. The differences marking these deposits in New England and generally through the northern United States[2] are the remarkable compactness and hardness of the subglacial till, due to compression under the ice-sheet, contrasted with the looseness of the englacial till; the abundance of glaciated stones and boulders in the former, and their comparative infrequency in the latter; and the usually greater proportion of large boulders in the englacial till. Weathering has changed the small ingredient of iron from the protoxide combinations which it still retains in the lower or subglacial till to hydrous sesquioxide in the upper or englacial till, giving to the latter a yellowish or reddish colour, in contrast with the dark grey or blue of the former.

Beds of modified drift, that is, of gravel, sand and clay, brought by streams from the melting ice-sheet, may occur (1) enclosed within subglacial till, (2) intercalated between the subglacial and englacial till, or (3) overlying all other drift formations. In the first and second cases they were deposited beneath the ice-sheet, or sometimes in the second case were laid down in front of the ice-border and afterward became covered with englacial till by an advance of the ice. Prof. C. H. Hitchcock describes abundantly fossiliferous marine modified drift which he believes to have been thus overlaid by englacial till at Portland, Maine.[3] To the third case, where the modified drift is superficial, belong osars and kames, formed in ice-walled channels, and the more extensive plains and valley drift spread along the course of the floods that descended from the ice-border to the sea. In districts to which the ice-sheet transported fragments of marine shells, these are liable to be found not only in both divisions of the till but also in any portion of the modified drift.

The geologists of Sweden record a similar order of drift formations in that country, there being generally recognizable subglacial and englacial till, with associated beds of stratified gravel, sand and clay.[4]

[1] A. Geikie's Text-Book of Geology, p. 903; Quart. Journ. Geol. Soc. vol. xxxii. 1876, pp. 184-190.

[2] Geol. Mag. Dec. II. Vol. VI. 1879, p. 283; Third Annual Report of the U.S Geological Survey, p. 297.

[3] Geology of New Hampshire, vol. iii. pp. 279-282; Geol. Mag. Dec. II. Vol. VI. 1879, pp. 248–250.

[4] American Journal of Science, III. vol. xiii. 1877, pp. 76-79; Great Ice Age, second ed. p. 405.

In north-eastern England it seems worthy of inquiry whether the Purple and Hessle boulder-clays may not be in like manner the subglacial and englacial till of a single ice-sheet, its modified drift being the Hessle gravel and sand. If this view be admissible, the Hessle beds containing *Cyrena fluminalis* and mammalian remains, where they are overlain by the Hessle boulder-clay, mark an extensive recession and subsequent advance of the ice.[1] Again, in north-western England the Lower and Upper boulder-clays and Middle beds of gravel and sand have the same relationship. These groups of drift deposits, bounded wholly or in part by the terminal moraines traced by Lewis, probably belong, like the conspicuous terminal moraines of the United States, to the second or last glacial epoch; while the Chalky boulder-clay, like the southern portion of the glacial drift in the Mississippi basin, extends beyond these to the limits of an earlier glaciation.

IV.—On Soda-Microcline from Kilimandscharo.[2]

By J. S. Hyland, Ph.D., M.A.,
Of the Geological Survey of Ireland.

THE material, in which this felspar occurs, was collected by Dr. Hans Meyer during his visit in 1887 to the East-African "snow-mountain," the Kilimandscharo, and kindly entrusted to me for description by Prof. F. Zirkel of Leipzig, to whom I desire to express my indebtedness for assistance and advice supplied me whilst working in his laboratory.

The rocks which possess this mineral as felspathic constituent are Nepheline- and Leucite-basanites,[3] and were found *in sitû* on the south and south-east flanks of the Kibo peak. As rock-constituent this felspar is presumably confined to the outflows from the higher peak—the Kibo[4]—as no trace of it is to be found in the large series of rock-specimens, which represent the materials of which the other and lower peak—the Kimawenzi—is formed.

It is remarkable that Gustav Rose,[5] who described the collection of specimens brought back from the same locality by Baron von der Decken in 1861 and 1862, mentions the occurrence in a rock he terms "trachyte" of a curious porphyritic felspar "whose crystals are rhombic prisms, so that a transverse section parallel to the best cleavage face appears as a rhomb." From his description I hold this felspar to be identical with that which Dr. Meyer collected.

[1] Quart. Journ. Geol. Soc. vol. xvii. 1861, pp. 446–456, and 473–5; Great Ice Age. second ed. pp. 372–380.

[2] The orthography used by R. Andree and A. Scobel in their Map of Africa (Leipzig, 1884) is here employed.

[3] Under "Basanite" Rosenbusch (Mikrosk. Phys. ii. p. 753) includes all Tertiary massive rocks, which possess as essential constituents plagioclase (usually a basic lime-soda-felspar), nepheline or leucite, augite, olivine and magnetite. The name was first employed by Alex. Brongniart (Classification et caractères minéralogiques des roches homogènes et hétérogènes, Paris et Strasbourg, 1827, pp. 102–105). This is the *first* occurrence of Leucite in Africa. For further particulars, see Hyland, "Ueber die Gesteine des Kilimandscharo und dessen Umgebung," Tschermak's Mitt. 1888, X. 203–267.

[4] 6090 metres high.

[5] Zeitschrift für allgemeine Erdkunde, Berlin, 1863, vol. xiv. p. 246.

In 1886 Mr. Miers[1] published an account of a felspar from the same locality, to which his attention had been called by Prof. Bonney, and concluded it to be an orthoclase, similar to that described by Brögger[2] in the Norwegian "Rhombenporphyr." A supplementary note[3] was issued in 1887 with analyses by Mr. Fletcher.

Several loose crystals were included in Dr. Meyer's collection, and these, although not quite fresh, favoured a study and determination of their characters.

The felspar is, when fresh, of a pearl-grey colour, with a highly vitreous lustre on both cleavage faces, and possesses the usual cleavage parallel to P and M, with a maximum length of 29 millimetres.

The following combinations were observed:

1. OP (001), $\infty \breve{P} \infty$ (010), ∞ P (110), $2 \breve{P} \infty$ ($\bar{2}01$) : $\infty \breve{P} \infty$ and $2 \breve{P} \infty$ well developed.
2. OP, ∞ P, $\infty \breve{P} \infty$: ∞ P (T and l) predominating: $\infty \breve{P} \infty$ is mostly very small and often almost disappears.

OP is sometimes represented by a cleavage face; the edges of the faces are mostly rounded off.

Mr. Miers has recorded these faces in the article already referred to. The presence observed by him of a macroscopic twinning according to the Carlsbad law with the striking peculiarity, that $\infty \breve{P} \infty$ (100) appears both as plane of composition and of twinning I was able to confirm as regards the second combination only, for wherever I found the face *y* ($2 \breve{P} \infty$) developed, there was no trace—optically or crystallographically—of any such macroscopic structure. Hence such crystals are in this respect simple individuals.

Upon careful examination of these twin-crystals a peculiar anomaly becomes apparent. The occurrence of the twin-structure demands that the two halves of such a crystal be symmetrical as regards $\infty \breve{P} \infty$; one is in fact led to expect at the one end a roof-like top, at the other a re-entering angle (einspringenden Winkel). The latter can at once be noticed on our felspar, but the roof-like top is wanting, its place being taken by one surface, the face OP. By striking this surface a portion flies off, and we recognize the characteristic form. Further, a section cut parallel to M ($\infty \breve{P} \infty$) from a crystal twinned after the Carlsbad type ought to be resolved under crossed Nicols into two fields optically different. In contradiction to this, such sections cut from the outermost portions of a crystal behave as if they were derived from un-twinned individuals. If, on the contrary, a section be cut parallel to the same surface, but from a point nearer the geometrical centre, one is able to observe the ordinary phenomenon and the inclination of the basal cleavages to each other can also be determined: this amounts to 42° 15′. That this curious anomaly does not owe its origin to any mistake in the directions of the sections, I was able to settle by measurement and comparison with the crystals from which the sections were

[1] Mineralogical Magazine, 1887, vii. pp. 10–11.
[2] Die silurischen Etagen 2 and 3, 1882.
[3] Min. Mag. 1887, p. 131.

prepared.[1] This conclusion is further supported by mechanically removing the outer portions of the crystals till the twin junction (Zwillingsnaht) is observed. In fact, we have probably here to deal with a nucleus twinned after the Carlsbad type, surrounded by felspar-substance free from such a structure.

From a crystallographical standpoint it is interesting to note the angle between P and M. This I have determined on several cleavage pieces, and obtain as mean 90° 3′. The physical condition of the surfaces was not very favourable for such a determination, still the variation was always very small. Miers observed 90°, and mentions that the variation never exceeded 16′. It is interesting to note, that Brögger determined 90° 3′ on the felspar from the dykes at Fredriksvärn.[2]

On examination under the microscope Mr. Miers[3] observed that parts of the crystals viewed by polarized light exhibited a well-defined cross-hatching parallel to the pinacoidal faces, but could, however, discover no trace of striation on sections parallel to OP. On the contrary, all the crystals I examined—ten in number—were seen to be built up of fine triclinic lamellæ of variable breadth. The examination of numerous sections cut parallel to OP showed that the lamellæ mostly follow the albite law; in such sections the extinction is nearly parallel and perpendicular to the edge P:M.

The extinction of the very fine striæ on OP may be measured as 1°—2°, the larger ones ascending to $3\frac{1}{2}$°. The surface of such a striated section under crossed Nicols is therefore never dark. Certain portions however exhibit no striæ, in fact the lamellæ appear to taper off and finally disappear. Brögger has made a similar observation.

Sections parallel to M possess an extinction-angle of 5°—6° and exhibit no striation.

One very thin section parallel to OP from the middle of a crystal showed at certain portions, in addition to the striæ of the albite type, a second system crossing these at right angles, thus producing a structure similar to though not perhaps identical with that of microcline. This microcline-structure is, however, to be seen best in sections cut at right angles to P and M. Such sections appear composed of very fine and distinct lamellæ crossed by another series perpendicular to the first and of irregular breadth. The extinction-angle is here 8°—11° to their length, but others appear to possess a straight extinction.

The triclinic character of the felspar is well marked in the rock-sections. The felspars of the ground-mass are identical with their porphyritic representatives, although the former are mostly lath-shaped. Where, however, the felspar forms laths of very small breadth, there is certainly no striation to be recognized; but this is an observation already made by those writers who have examined the felspar of the "Rhombenporphyr," to which, as has been

[1] The sections were made by Fuess of Berlin, and Voigt and Hochgesang of Göttingen.

[2] Brögger, op. cit. p. 259.

[3] l.c. p. 11.

stated, the felspar from Kilimandscharo bears a striking resemblance. I see nothing to lead one to conclude, that the ground-mass consists of felspar, which is partly monoclinic, partly triclinic, and as the result of my observations I must agree with Mügge,[1] when he accounts for the phenomenon by the fineness of the striæ combined with the small extinction-angle.

With regard to the chemical constitution the felspar was first analysed by Mr. Fletcher, who was unable to remove the numerous inclusions of glass and other material present. By means of a laborious method, which occupied nearly two weeks, I was enabled to separate these inclusions and to satisfy myself by microscopical examination of the powder that it was chemically pure.

The sp.g. was determined with aid of the Westphal balance to be 2·63 at a temperature of 18° C.

For comparison the composition of similar felspars from Svenör, Tyveholmen, and Pantelleria are given.

I. Felspar from Kilimandscharo (mean of two analyses) *Fletcher.*
II. do. do. do. *Hyland.*
III. Felspar from the Augitesyenite of Svenör. *Vogt.*[2]
IV. Felspar from the "Rhombenporphyr" of Tyveholmen. *Fischer.*[3]
V. "Plagioclase" from Cuddia Mida, Pantelleria. *Förstner.*[4]

	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	H_2O etc.	Totals.	Oxygen ratios.	Sp.g.
I.	60·78	2·32	23·0	2·84	trace	4·50	6·65	0·21	100·30	9·88 : 3·3 : 1	—
II	61·3	—[5]	23·1	3·02	—	5·34	7·11	0·09	99·96	9·08 : 3·02 : 1	2·63
III.	61·35	—	22·37	4·66	0·04	4·97	6·59	—	99·98	8·41 : 2·7 : 1	2·63
IV.	59·50	2·47	22·69	5·05	0·42	2·50	6·38	1·34	100·35	8·65 : 2·9 : 1	2·65
V.	66·63	0·72	19·76	0·38	0·30	4·86	7·31	—	99·96	12·1 : 3·1 : 1	2·55

From a chemical standpoint the constitution of this felspar is remarkable inasmuch as there is present, in addition to a large amount of soda, a considerable quantity of potash. Further, that the 3·02 % of lime found cannot be accounted for by inclusions of apatite or other lime-bearing minerals is evident, when we remember the pure condition of the powder analysed and the fact that the removal of the inclusions increased the amount of lime found, as a comparison with the analysis made by Mr. Fletcher shows. We may therefore consider this mineral as an admixture of lime, soda, and potash felspars, distinguished, however, from all other such compounds by the fineness of the triclinic lamellæ. My analysis is therefore equivalent to a molecular relation of 1 Mol. $Ca Al_2 Si_2 O_8$: 2·1 Mol. $KAl Si_3 O_8$: 4·02 Mol. $Na Al Si_3 O_8$. There is therefore present 1 Mol. $KAl Si_3 O_8$ to 1·91 Mol. $Na Al Si_3 O_8$. Mr. Fletcher gives $An_1 Or_{0·94} Ab_{2·11}$ and has therefore regarded the composition of anorthite as $Ca_2 Al_4 Si_4 O_{16}$. Förstner and others

[1] "Feldspath aus dem Rhombenporphyr von Christiania," Neues Jahrbuch, 1881, 2, p. 114.
[2] Brögger, op. cit p 261. [3] Mügge, l.c. p. 119.
[4] "Ueber die Feldspathe von Pantelleria," Z. f. Kryst. viii. 2 u. 3, p. 182.
[5] There was no trace of iron.

Locality.	Rock.	Molecular ratio.			Ratio of $KAlSi_3O_8$ to $NaAlSi_3O_8$		Sp.g.	Obliquity of Extinction.		Authors.
		$CaAl_2Si_2O_8$	$KAlSi_3O_8$	$NaAlSi_3O_8$	$KAlSi_3O_8$	$NaAlSi_3O_8$		On P	On M	
Pico do Teyde, Teneriffe	Vitreous Lava ...	1	1·96	4·94	1	2·52	2·59	3,80°	9,30°	Deville[1] & Förstner
Fréjus in the Esterelgebirge	Dacite	1	0·34	1·14	1	3·35	2·68	$\bar{1}°$—$\bar{3}°$	$\bar{2}$ —$\bar{5}$	Rammelsberg, Descloizeaux.[2]
Lille Frogner, Christianiageb.	Rhombenporphyr	1	0·80	0·90	1	1·12	—	$\bar{1}$ —$\bar{2}$	$\bar{5}\frac{1}{2}$—$\bar{6}\frac{1}{2}$	Brögger, Kjerulf.
Svenör	Augite-syenite ...	1	1·18	2·48	1	2·1	2·63	1 —2	?	Brögger, Vogt.
Cuddia Mida Pantelleria ...	Vitreous Pantellerite	1	7·36	16·86	1	2·29	2·56	2,10	9,80	Förstner.[3]
Kilimandscharo	Nepheline Basanite Leucite	1	2·1	4·02	1	1·91	2·63	1 —2	5—6	Hyland.

[1] Comptes rendus, 1844, 19, p. 46. [2] Rammelsberg, Min. Chem. 1875, p. 569, and Deville, Bull. géol. (2), 6, p. 410. [3] *loc. cit.*

take, however, only one molecule, which course has also been followed in this paper. Considering the formula to be $Ca\,Al_2\,Si_2\,O_8$, Mr. Fletcher's ratio would be $An_1\,Or_{1\cdot8}\,Ab_{4\cdot22}$.

The triclinic nature of the felspar having been shown, there remains only to add that according to Brögger's view the felspar should receive the name "soda-microcline."

Müggé[1] has described the occurrence of a "Natron-Mikroklin" in the younger igneous rocks from the neighbourhood of Naiwaseha Lake and (*in situ*) from the Kiwangaine Valley, two localities not far from the Kilimandscharo *massif*.[2] This felspar contains "along with Na and K some Ca." Unfortunately no quantitative analysis is given.

It is interesting to compare the Kilimandscharo felspar with others of a similar character from various districts. The following table will assist the comparison.

The interpositions are very numerous and may be recognized as olivine, augite-needles, apatite, particles of the ground-mass with its constituent minerals, and devitrified glass enclosures. The latter mostly possess a regularity in their relative positions to each other, and appear in sections cut at right angles to P and M rudely rectangular. At places grouped round the vesicles in the felspar occur very fine acicular crystals, which are brown and show a decided dichroism.

[1] N. Jahrbuch, 1886, Beilage-Band iv. p. 591.

[2] Kiwangaine lies 130 kilometres N.W. of Kilimandscharo.

These remind the observer of breislakite, although their presence in the felspar-substance instead of lining the vesicles may appear to contradict this diagnosis. If they be not breislakite they may possibly be cossyrite,[1] but their smallness does not permit of a more definite determination.

V.—On some Physical Changes in the Earth's Crust.

(*Part III.*)

By Charles Ricketts, M.D., F.G.S.

(*Concluded from* p. 119.)

On the western flanks of the Malverns, the Upper Silurians are folded in several great anticlinals and synclinals, formed parallel to the axis of the Hill itself. To the west of Ledbury and again near Woolhope these contorted strata dip beneath the Old Red Sandstone, which, as computed by Phillips, has a maximum thickness of 8000 feet,[2] that of the Upper Silurians being 2690 feet.

The thickness of the strata of which the Longmynd is formed has been estimated by the Government Surveyors at not less than 26,000 feet, as exposed in their highly inclined edges; the beds dipping at an average inclination of 60° to the W.N.W.[3] They thus appear as if they had been tilted by pressure against the more ancient rocks of the Caer Caradoc Range.

In each of these instances the immense accumulations formed may have had effect in causing the great disturbance to which the strata have been subjected. Whether the ridges of the Malverns or of the Caradoc Range are recognized as having once formed the summits of ancient mountains, or the dividing ridges between valleys, there is abundant evidence that a great thickness of sediment has been laid down in their vicinity, burying the slopes on their sculptured sides; the deposit being greater at a moderate distance, where the slopes extend deeper, than near the summits.

An example affording more conclusive evidence of the nature of the causes by which contortions and cleavage are produced occurs in the neighbourhood of Llangollen. At three different periods during Palæozoic times, namely, the Lower Silurian, the Upper Silurian, and the Carboniferous periods, the area around Llangollen continuously sank below the sea-level whilst deposits were accumulating. Three times they were raised above that level, and at the same time these deposits underwent denudation; *i.e.* previous to the deposition of the Upper Silurians, the Limestone and later Carboniferous rocks, and again as we observe at present. During each of these periods valleys were excavated to a depth so great, that the summits so far presented a mountainous character that they were raised 1500 feet and more above the then sea-level.

Previous to the deposition of the Upper Silurian strata, a pre-Wenlock valley was excavated in those of the Bala formation to a

[1] H. Förstner, "Ueber Cossyrit, ein Mineral aus den Liparitlaven von Pantelleria," Zeits. f. Kryst. 1881, V 348-362.

[2] Mem. Geol. Survey, vol. ii. pt. i. p. 102.

[3] Siluria, 1859, p. 23.

depth greater than that of the present valley; and in width extending from Llansantfraid Glyn Ceiriog, to the Cyrn-y-brain mountain, a distance from each other of seven miles in a direct line. Between these two points, though the strata have been deeply cut into, by the formation of the present valley of the Dee, no traces of the older rocks are discovered. Upon each side of this assumed valley, especially where the Upper Silurian strata abut against the older or Bala rocks, bendings and foldings have taken place, and slaty-cleavage has been developed, whilst at Llangollen, half-way between the two localities, the beds are seen, in the course of the river Dee, lying in a horizontal position. It has been already shown that such foldings could not have resulted from compression produced solely by subsidence to the extent indicated by the thickness of the deposit. This may be considered to be further confirmed in the same locality, where a repetition of the circumstances has so far taken place, that a deep valley, formed by the denudation of this Wenlock rock, had its bottom covered with the Red Basement beds of the Carboniferous system, and was subsequently buried underneath a deposit of 1025 feet[1] of limestone, which, instead of folding, has a dip of 15° only to the N.E., passing beneath 3000 to 4000 feet[2] of later Carboniferous strata. There are essential differences in the character of the deposits in the two periods; the Silurian, consisting of fine mud, which, long after its deposition, would remain in a plastic state and readily yield when subjected to irregular pressure, whilst the limestone would soon consolidate and become rigid.[3]

In the Ingleborough district the Lower and Upper Silurians are greatly bent and contorted, and the muddy deposits are also cleaved;[4] they were greatly denuded, and formed hills and valleys, previous to the deposition upon them of the Carboniferous limestone, "the lowest beds of which," as Playfair (§ 197) remarked, "contain in them many fragments of stone which, on comparison, resemble exactly the schistus underneath." A thickness of limestone, amounting to 600 feet, rests on the basset edges of the Silurians, and this is surmounted, as seen in the mountain peaks of

[1] The Carboniferous Limestone and Cefn-y-fedw Sandstone of North Wales by G. H. Morton, F.G.S., p. 21.

[2] The Coal-fields of Great Britain, by Professor E. Hull, 2nd ed. p. 99.

[3] I have seen at least ten instances where the Carboniferous Limestone during the period of its formation had been locally raised above the sea-level, and had thus been exposed for a time to atmospheric action and erosion. In eight of the examples thin beds of coal were formed, either resting immediately on the sculptured surface, or on a bed of clay which covered it; the thickest amounts to about a foot, at Ingleton; others varied down to a mere film of carbonaceous matter in the clayey deposit. Subsidence taking place, the deposition of the limestone again progressed to a great extent. The methods of weathering go to prove that the limestone had become consolidated previously to its elevation and erosion; in some cases shrinkage joints are present, and are filled with calcite, which stands out in relief on the eroded surface; the condition of these small joints indicates that the limestone must have become solidified before being raised above the sea-level, prior to the formation of the coaly beds. In some instances angular or weathered fragments of limestone are embedded in the clayey deposit which fills hollows in the surface of the limestone.

[4] They have been described in an Essay by Professor T. McK. Hughes, "On the Break between the Upper and Lower Silurians of the Lake District," Geol. Mag. Vol. IV. p. 346.

Whernside, Ingleborough and Penigent, by the Yoredales and Millstone Grit. These also were formerly covered by a considerable thickness of Coal-measures, as is evident from the presence of the Coal-field of Ingleton on the southern or down-throw side of the Great Craven Fault; whilst the whole series rested in a position as horizontal as when first laid down, though, in order to permit the accumulation of this succession of strata, they must have sunk continuously whilst deposition progressed, until their base reached a depth of 4500 feet, as calculated by Professor John Phillips.[1]

The difference in the conditions of the two series is remarkable; for if the foldings in the more ancient strata are attributable to lateral pressure, due to subsidence, they should have occurred also, at least to some extent, in the Carboniferous rocks in which subsidence took place to the depth of nearly a mile. It is therefore necessary to search for other causes likely to effect this pressure.

Sir Charles Lyell, when commenting on the presence of the "mud lumps" at one or other of the mouths of the Mississippi, attributed their formation to "the downward pressure of the gravel, sand and sediment, accumulated during the flood season off the various mouths of the river, upon a yielding bottom of fine mud and sand. A mass of such enormous volume and weight, thrown down on a foundation of yielding mud, may well be conceived to exert a downward pressure, capable of squeezing and forcing up laterally some parts of the adjoining bottom of the gulf, so as to give rise to new shoals and islands." He further states "that railway engineers are familiar with the swelling of a peat moss, or the bed of a morass, on some adjoining part of which a new embankment has been constructed.[2] A friend who, many years ago, was engaged in superintending the erection of a fort near the mouth of the Medway, relates that the unloading of a cargo of materials to be used in its construction caused a considerable deviation from the perpendicular, and great difficulty was likewise experienced in keeping the structure erect as it progressed, on account of the muddy deposit, on which the foundations rested, giving way irregularly.

Captain C. E. Dutton, of U.S. Geological Survey, states that "wherever the load of sediment becomes heaviest, there they sink deepest, protruding the colloid magma beneath them to the adjoining areas which are less heavily weighted, forming at once both synclinals and anticlinals."[3]

Though Lyell, as has been already remarked, considered that the intense pressure by which foldings of strata have been caused, has been exerted without violence, and in the most gradual manner, he omitted to apply the phenomena, described by him as occurring at the mouth of the Mississippi, in explanation of the cause of contortions in older rocks.

[1] Report on the Probability of the Occurrence of Coal in the Vicinity of Lancaster, 1837.

[2] Principles of Geology, 10th edit. vol. i. p. 453.

[3] The Earth's Physical Evolution, The Penn Monthly, 1876, p. 424; also a resumé of the same, by Rev. O. Fisher, GEOL. MAG. Dec. II. Vol. III. p. 374.

It is deserving of consideration whether, and to what extent, foldings of strata, and other concomitant phenomena, have been dependent on varying accumulations of material. A river brings down and deposits a greater quantity and coarser particles, in an estuary or bay, or in the sea, along the direction of its current, than at a distance, where the finer mud is spread out; when this occurs above an underlying muddy deposit, there would be a tendency for the heavier materials to sink down and, producing displacement, so cause lateral pressure similar to that to which these foldings have been

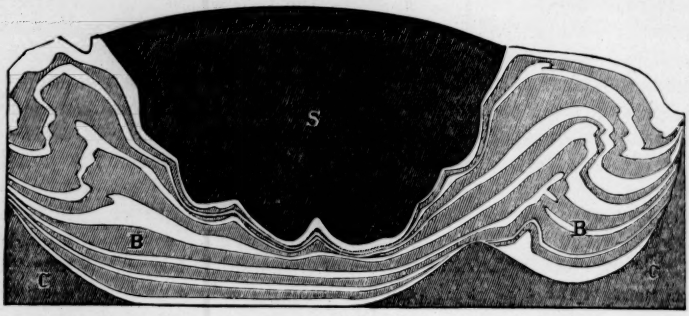


Fig. 4. C, consolidated Clay; B, layers of Clay, originally in horizontal beds, but squeezed into folds by the vertical pressure of S, sand, extra weight being applied.

attributed since the days of Sir James Hall. Effects corresponding to these suppositions can be readily induced by taking clay dried and reduced to powder and spread in consecutive layers of different colours horizontally in a box or trough. On the access of water, through holes previously made in the bottom and sides of the box rather than by pouring it on the surface (for that would prevent the free escape of the included air) the clay becomes soft and plastic; when fully saturated, by pouring sand on the clay at some special part and applying extra weight, which will be requisite in the experiment, this will not only cause the heavier substance to subside into the plastic mass of clay, but, whilst pressing downward, it will at the same time squeeze outward the clay-beds, causing the layers immediately underneath to be formed into films; these, however thin, are still continuous with those on the sides, which are rendered considerably thicker than in the original state of the beds, and are curved into folds, representing contortions similar to what are constantly met with, having been produced under circumstances analogous to what must frequently occur from natural causes (see Fig. 4).

That the form of the contortions may be greatly influenced by the contour of the solid ground is well illustrated in the effects produced by the presence of the mound (⊙) of consolidated clay (C) in the figured model. (The interior of the models was displayed by cutting through them, before they became solid, by means of a piece of string, previously arranged for that purpose.)

From the great thickness of certain geological strata, from the amount of deposit known by borings to occur in the Deltas of great

rivers, and what may be inferred from the contour of bays, which are the submerged continuation of valleys into which rivers flow, there must be sufficient, perhaps more than sufficient, power developed, not only to account for progressive subsidence of the Earth's crust, but also to induce simultaneously, when circumstances are favourable, such lateral pressure, in the manner suggested, as would terminate in contortion and cleavage. However frequently such contortions may occur at the present time, opportunities of proving their existence must indeed be rare, for, formed beneath the surface of the water, if by any means they should become raised above the sea-level, the exposed surface of such easily disintegrated materials would be soon washed away by the waves.

The contortions which occur in metamorphic rocks must, at least in a great measure, be dependent on other causes than those which have been considered. The abrupt bendings they have sometimes undergone; the wavy wrinkled state into which they are at other times thrown, indicate that, to use an expression made to me by the Scotch chemist and mineralogist, Professor M. F. Heddle, M.D. of St. Andrews, "they must be due to some internal change." Mr. T. F. Jameson, F.G.S., "supposes that the heat from the interior of the earth gradually approached the base of the sedimentary beds and, by heating, caused them to expand and thereby become wrinkled into huge folds, as a necessary consequence of a great mass of swollen matter having to find room in the space occupied by the same matter when in a cold and contracted state.[1] Considered alone, this does not appear an altogether satisfactory explanation of the formation of such contortions as sometimes occur in metamorphic rocks. If the abrupt bendings alluded to are entirely the result of expansion from being subjected to excessive heat, it might be expected that in all cases foldings would result to a greater or less extent; or that, if so great expansion does take place, on the cooling and consequent contraction of the mass, the resulting fissures should, in gneissic and granitic rocks, have their sides separate from each other to a greater extent than is the case; the average width of which does not appear to be greater than in unaltered strata. The shrinkage of basalt and lavas forms prisms, the joints of which are in close contact with each other, though the mass in which they exist has cooled from an absolutely molten state. Mr Charles Babbage[2] calculated, from the result of experiments by Mr. H. C. Bartlett, of the United States Engineers, that if a mass of granite, twenty-five miles in thickness, be heated to 1000°, expansion would take place to the extent of 637 feet only; that is, there would be an extension of its bulk equivalent to about $\frac{1}{210}$ of its size in a cold state. The results of other experiments, made by Mr. A. J. Adie, and by Mr. T. Mellard Reade,[3] do not greatly differ from those of Mr. Bartlett.

The expansion of rocks by increase of heat has by some been considered to be the cause of elevation of the land. Doctor James

[1] Quart. Journ. Geol. Soc. vol. xxvii. p. 105.
[2] The Ninth Bridgewater Treatise, Appendix, p. 222.
[3] Origin of Mountains, p. 109.

Hutton, in his celebrated work, states that "the power of heat for the expansion of bodies is, so far as we know, unlimited; but, by the expansion of bodies placed under the strata at the bottom of the sea, the elevation of those strata may be effected; the question to be resolved regards the actual exertion of this power of expansion, how far it is to be concluded as having been employed in the production of this earth above the level of the sea. There has been exerted an extreme degree of heat below the strata formed at the bottom of the sea, and this is precisely the action of a power required for the elevation of those heated bodies into a higher place. Therefore, if there is no other way in which we may conceive this event to have been brought about, consistent with the present state of things, or what actually appears, we shall have a right to conclude that such had been the order of procedure in natural things, and that the strata formed at the bottom of the sea had been elevated, as well as consolidated, by means of subterranean heat."[1] This coincides with the hypothesis advanced by Mr. Charles Babbage, nearly forty years subsequently, as a cause of disturbances of the earth's crust; having been suggested to him by the changes of level, proved to have occurred within a comparatively short period, at the site of the Temple of Serapis, in the Bay of Naples.[2] Mr. T. Mellard Reade considers "mountain ranges are ridgings up of the earth's crust, which take place only in areas of great sedimentation. That the existing cause of the various horizontal and vertical strains, ending in the birth of a mountain-range, is the rise of the isogeotherms and consequent increase of temperature of the new sedimentaries, and that portion of the old crust they overlie. The tendency to expand horizontally is checked by the mass of the earth's crust bounding the locally heated area, and is therefore forced to expend its energies within itself; hence arise foldings of lengthening strata, re-packing of beds, ridging up, and elevatory movements, which occur in varied forms according to the conditions present in each case."[3] He thinks "this mass of rock cannot expand laterally, for in that case it would displace the crust of the earth surrounding the affected area, nor downwards, for that would displace the foundations of the earth itself. It is only free to expand upwards."[4]

The expression, "*if there is no other way*," indicates that Hutton felt some misgiving in supposing the elevation of the strata was due to the effect of expansion from the accession of subterranean heat, and that he suggested the theory for want of a better. With respect to this proposal, as advanced by Babbage, the Rev. O. Fisher remarks that "the heat conducted upwards into the new deposits must be abstracted from the couches beneath, so that there can be no absolute increase in the amount of the heat beneath the area in question, except such as is supplied laterally."[5] It therefore follows, that there would be as great a diminution in size of the contiguous

[1] Theory of the Earth, by James Hutton, M.D., F.R.S.E., 1795, vol. i. p. 123.
[2] Proc. Geol. Soc. vol. ii. p. 73; Quart. Journ. Geol. Soc. vol. iii. p. 186.
[3] Origin of Mountain Ranges, by T. Mellard Reade, C.E., F.G.S., p. 326.
[4] Page 10.
[5] Physics of the Earth's Crust, p. 82.

portion of the interior mass as would be equivalent to the increased size caused by the heat supplied to the later formed strata. Independently of this, the calculations deduced from the expansion of rocks by heat, as determined by the experiments of Bartlett, Adie and Mellard Reade, indicate that when exposed to high degrees of temperature, the enlargement is not sufficient to induce more than a fractional part of what is attributed to it.

Elevation of land does not occur where the greatest amount of accumulation is in progress; on the contrary at the mouths of great rivers, where simultaneously with, or rather, as is here contended, in consequence of the immense accretion of sediments derived from the erosion of the land, and brought down and deposited, subsidence has been proved to have taken place to a very great extent, forming conditions such as it is considered by most would render the deeply buried strata liable to be exposed to an increase of heat supplied from below. It is in those areas where the greatest amount of denudation has taken place, and the land has become lightened in the process of removal, that elevation occurs.

It is evident that where foldings occur, in what may be designated unaltered strata, they have been formed at the sea-level or at some moderate depth; if in those in which extensive chemical change has produced a re-arrangement in their constituent components, they have been buried beneath a very thick covering of strata, which has enabled them to become affected by internal heat. However high they may subsequently have become elevated, this pre-supposes the removal of this immense quantity of material before the metamorphic rock became exposed at the surface, and formed a portion of the structure of mountains.

From the examination of the geological structure of Britain it is seen that the erosion of these hard rocks, and their formation into hills and valleys, during a former period, though they may have subsequently sunk below the then sea-level, and been deeply buried beneath large accumulations of sediment, have still had a great effect in determining the present contour of the land. The flanks of buried valleys and the summits of ancient hills again become elevated and exposed by the removal of the less consolidated strata; the hardness and indestructibility which preserved them before, again enables them to stand conspicuous at a higher altitude than later deposits, and to form what has been called "the core of the mountain"; even the old valleys sometimes again serve the purpose by and for which they were originally formed; and streams run in them in the same course, often in the identical old channels.

VI.—Mr. E. T. Newton on Pterosauria.

By Dr. G. Baur, New Haven, Conn.

THE paper by Mr. E. T. Newton[1] "On the Skull of *Scaphognathus*" is one of the most important contributions to the morphology of

[1] Newton, E. T., "On the Skull, Brain, and Auditory Organ of a New Species of Pterosaurian (*Scaphognathus Purdoni*), from the Upper Lias near Whitby, Yorkshire," Philos. Trans. Lond. 1888, vol. 179, pp. 303-537, pl. 77-78.

the Pterosauria [1] which has been published. There are a few points, however, which appear to me to need correction or a fuller explanation,

1. *The "prefontals,"* Newton.

When Mr. Newton had the great kindness to show me the specimen, which he had worked out with so much skill, I suggested to him that the bones called by him "prefrontals" (*loc. cit.* p. 505) were probably parts of the nasals only. It seems to me quite probable that this view is correct, and I give the following reasons:

1. If the "prefrontals," Newton, represented these bones, they would have a position different from that in any other form of the *Monocondylia*, Haeckel, 1866 (*Sauropsida*, Huxley, 1869). They would be placed inside of the nasals.

2. They would not form a part of the orbit, a condition found in all the Monocondylia in which a prefrontal is present. As we can hardly expect such a fundamental difference between the Pterosauria and the other reptiles, this view is very improbable.

But Mr. Newton remarks, if the bones called prefrontal and nasal represent a single element, there will be no distinct prefrontal bones. In fact, the prefrontal is not free in the Pterosauria, exactly as in birds. The prefrontal probably forms the anterior and outer process of the frontals, contributing to the upper anterior border of the orbit, or it may be co-ossified with the lachrymal, as stated by Dr. Günther. The processes of the frontal, which I am inclined to consider as prefrontals, are well represented in figs. 1, 2, 3 in Mr. Newton's memoir.

The figure given by Hallmann [2] represents the relations very well.

The bones called "nasals" and "prefrontals" by Mr. Newton therefore represent only one pair of bones, the nasals.

2. *The quadrato-jugal and jugal.*

The exact connection between these bones is now determined, by Mr. Newton's studies, for the first time; but the peculiar resem-

[1] I use the name *Pterosauria*, which was introduced by Kaup in 1834 in the form "Pterosaurii" (Kaup, J. J., "Versuch einer Eintheilung der Säugethiere in 6 Stämme und der Reptilen in 6 Ordnungen," Isis, 1834, p. 315.

In the same year Carus established the group "*Alata*" to contain *Pterodactylus* (Carus, Carl Gustav: Lehrbuch der vergleichenden Zootomie, 2 Aufl. Leipzig, 1834, pt. i 25).

In 1835 de Blainville called those reptiles the *Pterodactylia* (preoccupied by Latreille, 1825, for a "family of Birds," *Pterodactyli*) (de Blainville, H., "Description de quelques espèces de Reptiles de la Californie, précédée de l'analyse du système général erpétologie et d'amphibiologie," Nouv. Ann. du Musée, tome iv. p. 238, Paris, 1835). In the same paper the Ichthyosaurs are separated from the Plesiosaurs, under the names *Ichthyosauria* and *Plesiosauria*. These names antedate the *Ichthyopterygia* and *Sauropterygia* of Owen by twenty-five years. *Ornithosauri* was used by Fitzinger in 1837 (Ann. Wien Mus. Naturg. 1837, vol. ii. p. 184), and adopted by Bonaparte in 1838 (Nuovi Annali delle Scienze naturali, Bologna, 1838, vol. i. pp. 391-397). In 1841 Owen gave the name *Pterosauria* (Brit. Assoc. Rep. (1840), London, 1841).

[2] Hallmann, Eduard, "Die vergleichende Osteologie des Schläfenbeins" (Hanover, 1837), pl. ii. fig. 4.

blance between these elements and the corresponding bones in the Sauropoda[1] is not stated.

In both, the jugal has two upper processes, which form the anterior and inferior part of the orbit.

In *Diplodocus* the quadrato-jugal is connected directly with the maxillary; a condition which seems to exist in *Scaphognathus*. Newton says the maxillary "comes below the lower angle of the jugal, and seems to meet the quadrato-jugal" (p. 505). Some of the Testudinata (*Staurotypus, Aromochelys* . . .) show a similar structure.

The tendency of the quadrato-jugal in *Scaphognathus* to separate the postorbital from the jugal is very remarkable.

3. *The "supra-temporal."*

"At the outer end of each paroccipital process, and forming the hindermost angles of the skull, there seems to have been a small separate bone, which occupies the position of, and probably is the supratemporal, a bone said to be constantly present in Lizards." (Newton, p. 507.)

A supratemporal bone has not been found in any member of the group to which the Pterosauria belong. It is absent in the Phytosauria, Crocodilia, Dinosauria, and Aves. This makes it probable, that it did not exist as a free element in the *Pterosauria*. The supratemporal, Newton, may be only a part of the paroccipital or squamosal.

4. *The "basipterygoid processes."*

Mr. Newton suggests the possibility that these processes may be separate bones (p. 507), but on p. 509 he is inclined to consider these as *elongated* basipterygoid processes. It is quite evident that they cannot represent anything else.[2] In the Sauropoda they are developed in the same way.

5. *Some notes on the synopsis of genera of the Pterosauria given by Mr. E. T. Newton.*

In his "Notes on Pterodactyls"[3] Mr. Newton follows Lydekker in adopting his (Lydekker's) genus *Ptenodracon*.[4]

This name is a synonym of *Ornithocephalus*, Seeley (non Sömmering). Both Lydekker and Newton say, without apparent authority, that Zittel[5] had shown Seeley's name *Ornithocephalus* to be inadmissible. Zittel did not admit *Ornithocephalus*, Seeley,

[1] Marsh, O. C., "Principal Characters of American Jurassic Dinosaurs, part vii. On the Diplodocidæ, a new family of the Sauropoda," Amer. Journ. Sci. vol. xxvii. (Febr. 1884), pl. iii. figs. 1–3.

[2] Prof. Fraas considered these parts even as "hyoids," Palæontographica, vol. xxv.

[3] Newton, E. T., "Notes on Pterodactyls," Proc. Geologists' Assoc. vol. x. No. 8, 1888.

[4] Lydekker, Richard, "Catalogue of the Fossil Reptilia and Amphibia in the British Museum," Part i. London, 1888, p. 3.

[5] Zittel, Karl A., "Ueber Flugsaurier aus dem lithographischen Schiefer Bayerns," Palæontographica, vol. xxix. 1882, p. 80.

because he considered it to be the same genus as *Pterodactylus*, and this was his only reason for rejecting the name.

Zittel's words are: "Die Gattung *Ornithocephalus* (Sömmering)[2] wird von Seeley folgendermaassen characterisirt: '*Ornithocephalus*. —The anterior nares are entirely separated from the middle holes of the head, both being small and the latter exceedingly small. The head is short. The neck is short. The large ischium appears to be excluded from the acetabulum, and the ilium appears to extend less far forward than in *Pterodactylus*.' Diese Diagnose stützt sich lediglich auf die ungenaue Abbildung Sömmering's. Es bedarf nur eines Blickes auf Taf. xii. fig. 3 [in Zittel's work], sowie auf die obigen Bemerkungen um sich zu überzeugen, dass die für die Gattung *Ornithocephalus* angegebenen Merkmale theils am Original garnicht vorhanden sind, theils ihre Erklärung in dem Erhaltungszustand finden. *Ornithocephalus*, Sömmering,[1] fällt somit, wie schon alle früheren Autoren annahmen, unter die Synonymik von *Pterodactylus*."

If "*Ornithocephalus brevirostris*, Sömmering," is different from *Pterodactylus*, the name *Ornithocephalus*, restricted by Seeley to this species, has to stand, and not *Ptenodracon*, Lydekker.

The genus *Ornithopterus* (v. Meyer, 1838), of which Huxley says, "I am much inclined to suspect that the fossil upon which the genus *Ornithopterus* has been founded appertains to a true bird," is still considered by Newton as a distinct genus of the Pterodactyls. Prof. Huxley and Newton have overlooked the fact that H. v. Meyer retracted this genus in 1860, in his great work, "Reptilien aus dem lithographischen Schiefer des Jura."

H. v. Meyer,[2] after the examination of the original specimen, explained that his former statement was incorrect, and that his *Ornithopterus* could not be distinguished from *Rhamphorhynchus*, and was probably identical with *Rhamphorhynchus Gemmingi*.

REVIEWS.

I.—The Subterranean Treasures of Italy. ("I Tresori Sotterranei dell' Italia," &c., per il Cavaliére Guglielmo Jervis, Conservatore R. Mus. Indust. Ital., F.G.S., &c.) Part IV. Complete in itself. The Economic Geology of Italy. 8vo. pages xxxvi and 516. With 62 Woodcuts and Lithographs. (E. Loescher, Turin, Florence, and Rome, 1889.)

THIS fourth and last volume of Chevalier Jervis's valuable work on the underground riches of Italy treats of the topographical distribution of the stones and marbles useful for building and decoration, for architectural ornaments and sculpture; also for making lime, cement, mortar, stucco, plaster, etc. Not only are particular localities carefully described and often illustrated, but the

[1] Zittel ought to have written *Ornithocephalus* (Seeley).

[2] Meyer, Hermann v., "Reptilien aus dem lithographischen Schiefer des Jura in Deutschland und Frankreich." Frankfürt a. M. 1860, p. 141.

geology of the district and its component rocks or strata are briefly noticed in smaller type. There are, further, short historical sketches of the uses to which the materials have been applied during the course of thirty centuries, by the Etruscans and Romans, and by the Greek, Egyptian, Phœnician, and Pelasgian colonists of Southern Italy, and their several descendants down to our own times. Hence we are here shown of what stones a very considerable number of classic temples and other edifices, monuments, tombs, votive altars, and statues were constructed. Descriptive notices also are given of catacombs, aqueducts, roads, bridges, and other public works of the ancients and moderns,—all from a geological standpoint. Thus the great antiquities of Italy have been brought forward in a novel and highly intelligent and interesting manner, far beyond the reach of existing Guide-book literature; and both tourists and others can, like true students, not merely seek to collect new facts, but study known facts better.

The localities of rocks of economic value (excepting sands and clays) are indicated, that are within accessible distances from towns, roads, railways, and ports. Some of the most interesting places referred to as containing objects worthy of notice by the lithologist and geologist, as well as the antiquary, are—Volterra, Cortona, Carrara, Fivizzano, Lerravezza, Rome, Tivoli, Naples, Pozzuoli, Syracuse, and Sardinia.

Our author seems to us to have succeeded in carrying out Pliny's object, when he was striving (as he said 1800 years ago) to treat old subjects in a fresh readable light. The old Roman's opinion is given as an epigraph to the Introduction at page xxi, and may be read as follows:—"It is difficult to give novelty to ancient things and authority to new; brightness to obsolete and light to obscure things; pleasure to the fastidious and faith to the doubting; a naturalness indeed to everything and everything to its own nature."

This volume mainly consists of three parts. 1. The Alps (pp. 32–164, with 19 illustrations); 2. The Apennines and the volcanoes, both active and extinct (pp. 165–414, with 30 illustrations); 3. The Islands of Sardinia and Sicily (pp. 417–482, with 9 illustrations). These regions are treated in detail according to their hydrographic basins, provinces, and communes, which yield building-stone, marble, etc.

A list of the Illustrations is given at pp. xi–xiv, with indications of the materials used in the several buildings shown,—as, for instance, part of a Pelasgian wall at Croton (Cortona), made of great blocks of Eocene sandstone (pietra serena); part of Etruscan funereal monument, in Miocene alabaster; Etruscan mortuary tomb, of Quaternary travertine; the "cloaca maxima" at Rome, constructed of Post-pliocene volcanic tuff, of travertine from Tivoli, and of Post-pliocene peperino; Roman amphitheatre at Verona, of compact Jurassic marble; the Pantheon at Rome, with granite columns; the baker's house at Pompeii, with mill-stones of late Tertiary leucitic lava; pavement of the "Via Appia," of Post-pliocene basalt; pavement of the Roman mole of Puteoli (Pozzuoli),

of Post-pliocene trachyte of the Solfatara; triumphal arch of Augustus at Susa, the cathedral of Milan, and the front of the Palazzo Madama, Turin, of white Pre-palæozoic marble; and the Railway-station at Turin, of Pre-palæozoic syenite and gneiss. The sources of the material of these and of the numerous other pictured buildings, statues, etc., are carefully given. Besides those mentioned above there are views and sketches of the mountainous districts that yield marble, of some quarries, and the rough modes of hauling the blocks by means of cruelly used bullock-teams; also of Vesuvius, Lipari, Pompeii, cement-factories, palaces, churches, bridges, statues, catacombs, cave-dwellings of Posilippo, ancient amphitheatres and temples (Roman and Greek), and of the enigmatical pre-historic buildings (Nuraghi) of Sardinia.

At page xv is a list of sixty-five authors who have described the economic stones and other such Italian materials used in construction, decoration, inlaying, etc.

The Preface and an Introduction, explaining the author's plan and intention, with a brief exposition of the bearing of Geology on the subject of his work, follow appropriately to page xxxii.

At p. xxxiii a list of the economic rocks of Italy (eighty-nine) described in this volume is given. The effects of atmospheric action on the different kinds of rock and stony materials are noted at pp. xxxiv-xxxv; and the relative composition and character of cements, mortar, and plaster, at p. xxxvi.

Page 1 commences with a catalogue of the ancient and modern names of places, the economic geology of which is mentioned in the volume. At pages 2 and 3 is a provisional or tentative Table of the chief geological formations occurring in the Italian Alps, according to the writings of accredited geologists, with indications of the different economic materials found in or made from the several rocks. At pages 4 and 5 is a similar carefully-constructed Table of the rocks and strata of the Apennines and their associated volcanoes. A similar Table for Sicily is presented at pp. 6 and 7; and one for Sardinia at p. 8. A concise list of leading Fossils for each of the above-mentioned regions is given at pp. 9 and 10. Pages 11-13 are occupied by a classified and alphabetical list of the Communes and Provinces mentioned in the Volume, with the respective numbers of the paragraphs concerned. At p. 32 is a list of fifty-five modern cities where Italian marbles, or ornamental and building stones have been used.

Not only is this volume full of matters of general interest to the educated reader, but it is a valuable repertory of useful information for provincial and communal administrations, for capitalists, technical colleges, and geologists.

Two useful and carefully compiled Indexes complete the volume. 1. An Alphabetical Index of the Communes in which the several economic materials described in the volume, and *here arranged under their lithological headings*, have been met with. 2. A simply Alphabetical Index of the Communes in which the said rocks have been found.

Vols. i.—iii. of Signor Jervis's "Subterranean Treasures of Italy" treat of the "Topographical Mineralogy" of that kingdom, under the three same geographical headings as are used in vol. iv. These three earlier parts (1873, 1874, 1881) constitute a work complete in itself (price 40 lire); and so does vol. iv. (price 15 lire). We have already[1] recommended with pleasure some of Signor Jervis's books on the fossil fuel, mineral waters, etc., of Italy; and now we again can only praise his long-continued efforts for thirty years (we believe), in gathering together and publishing in convenient form so many well-considered facts and so much information valuable for thinkers, workers, and capitalists, not only in his adopted country, but throughout the civilized world. This too is the more creditable to him, as he has not spared his private means, any more than his arduous and continuous exertions in travel and research. We hope and trust his labours will be rewarded with the honour and profit so well deserved. T. R. J.

II.—Prof. Dr. von Zittel on Palichthyology.

Karl A. von Zittel, Handbuch der Palæontologie. Palæozoologie. Band III. Lief. I. II. (R. Oldenbourg, Munich, 1887–88.)

(*Continued from page* 130.)

Dipnoi.

THE chapter on Dipnoi commences with a list of the more important works relating to its recent representatives, and an interesting brief discussion of the systematic relationships of the group. To the Ctenodipterini are referred *Dipterus*, *Ctenodus*, *Palædaphus*, *Holodus*, and other more fragmentarily-known fossil forms; and a supplementary section includes *Megapleuron*, *Conchopoma*, and the problematical *Tarrasius*. *Ceratodus* is the only fossil genus of Sirenoidei; and Dr. Fritsch has recently suggested that this is wrongly thus placed, exhibiting no characters by which it can be separated from the Ctenodipterini.[2]

Ganoidei.

A long introductory section to the important group of Ganoids comprises, in addition to the usual general topics, a number of valuable, and, to a large extent, novel remarks upon the various stages of development met with in the vertebral column of these fishes, illustrated by several woodcuts. Commencing with the notochordal forms, and then referring to the false appearance of vertebræ in the Pycnodonts, Dr. v. Zittel proceeds as follows: "As a rule there first appears on the underside of the notochord an arched bony plate (hypocentrum), which in the caudal region is clasped by the inferior arches and sends upwards shorter or longer

[1] Geol. Mag. Dec. II. Vol. VII. June, 1880.
[2] Fauna der Gaskohle, vol. ii. pt. 3 (1888), p. 65.

lateral processes. Sometimes also the hypocentrum consists of two pieces, which meet together beneath the notochord. Besides the hypocentrum there is seen somewhat above on both sides a keel-shaped plate (pleurocentrum), pointed below but rounded above, by which the notochord is partly, though not completely, enclosed. In the next stage both the upwardly pointed hypocentra and the downwardly pointed pleurocentra extend so far, that a zig-zag appearance is produced laterally, and as the two pleurocentra also often unite on the dorsal aspect, the vertebra is now formed of two thin horse-shoe-shaped half-rings, completely encircling the notochord. In such half-vertebræ the upper arched pieces (pleurocentra) never partly overlap the lower pieces (hypocentra), as Heckel has erroneously stated. In the genus *Eurycormus* the vertebral column consists in its front half of about equally developed horse-shoe-shaped half-rings, while in the caudal region the attenuated ends of the hypocentra and pleurocentra unite dorsally and ventrally, thus forming two closely apposed delicate rings completely surrounding the notochord ('falsche Hohlwirbel,' Vetter). The caudal region of the recent genus *Amia* exhibits this stage, except that the ossification has proceeded further inwards and to a great extent constricted the notochord. In a number of Jurassic Lepidosteoids (*Aspidorhynchus*, *Belonostomus*, *Histionotus*, *Ophiopsis*) and Palæozoic Crossopterygians (*Rhizodopsis*, *Megalichthys*), the vertebral centrum consists of a single thin cylindrical ring with a smooth or vertically striated outer surface. That the 'Hohlwirbel' or 'Ringwirbel' results from the lateral fusion of two half-rings, is conclusively proved, for example, by *Aspidorhynchus*, for here the caudal region always consists of hollow vertebræ (Hohlwirbel), while the front abdominal region mostly consists of half-vertebræ, of which the hypo- and pleuro-centra form rings closed dorsally and ventrally, but remain completely separated by a suture laterally."

In the systematic description of the Ganoids, the doubtful fragmentary remains described by Pander from the Upper Silurian of the Island of Oesel are briefly noticed; and then follow the three problematical "orders" of Pteraspidæ, Cephalaspidæ, and Placodermi. Alth's determination of the simple shield named *Scaphaspis*, as placed ventrally beneath the more complex shields of *Pteraspis* and *Cyathaspis*, is adopted; and the restored figure of the two connected shields of *Pteraspis* is reproduced. These fossils are common in the Old Red, not of Scotland (as stated), but of Western England. We would also remark that *Palæaspis*, Claypole, so far as defined, falls in the genus *Holaspis*. A very complete synopsis of the Cephalaspidæ is given, including references to the species; and the histological remarks are illustrated by Huxley's figures of microscopical sections of the shields. Both these groups have been so well treated by Ray Lankester, that it is comparatively easy to summarize our present knowledge of their various representatives; but with the Placodermi the case is very different, and a carefully prepared digest of the existing literature of the subject shows how much revision of the typical European genera is required. Such a

revision is now in progress by Dr. R. H. Traquair, and three contributions to the subject have already appeared.[1]

A few genera "incertæ sedis" succeed the Placodermi, e.g. *Menaspis*, *Oracanthus*, *Stichacanthus*, etc. Of these, *Oracanthus* is now definitely proved to be an Elasmobranch;[2] and all the associated forms, except *Menaspis*, will doubtless share the same fate when microscopically examined.

The more typical "Ganoids" are commenced with the Chondrostei, of which only two families are recognized—the Acipenseridæ and the Spatularidæ. Of the former, *Acipenser toliapicus*, Ag., is recorded from the London Clay of Sheppey, and we might add *A. ornatus*, Leidy, from the Miocene of Virginia.[3] The supposed existence of the family Spatularidæ in the Devonian age (*Macropetalichthys*) is incredible; and the recent researches of Davis[4] and Traquair[5] upon the Liassic *Chondrosteus* prove conclusively that this genus belongs to an otherwise unknown extinct family. As indicated by its generic name, *Crossopholis* possesses small pectinated scales, and these are worthy of note inasmuch as they necessitate the modification of one point in the stated family-definition.

The Acanthodidæ follow the Chondrostei, and are raised to the rank of an order, without, however, any subdivision into families. Huxley's conclusion is adopted that these fishes are intermediate between Selachians and Ganoids; and the principal genera are briefly noticed. The order of Crossopterygidæ occupies the next eighteen pages; and the first family is typified by *Phaneropleuron*, which some authors would place in the Dipnoi. The Cœlacanthidæ are treated mainly in accordance with Reis' recent memoir;[6] and then follow the Devonian and Carboniferous genera included by Huxley in his families Saurodipterini and Glyptodipterini. The latter have been remarked upon lately by Dr. Traquair in the pages of this MAGAZINE;[7] and the most recent information concerning Devonian Crossopterygians will be found in this article.

Polypterus naturally closes the systematic consideration of the Crossopterygian Ganoids, though no members of the Polypteridæ or Polypterini have hitherto been detected among fossils. Next are placed the Palæoniscidæ and Platysomidæ, grouped together in an order named by the author, Heterocerci, and unaccountably removed far from the Chondrostei, with which they are associated by Dr. Traquair, whose elaborate detailed researches form the basis of the chapter. It is unusual, indeed, not to place the Crossopterygians before the Actinopterygians, as being referable to a lower stage of fish-evolution; and if the definitions of "Chondrostei" and "Hetero-

[1] GEOL. MAG. [3] Vol. V. (1888), pp. 508–511 (General); *ibid.* Vol. VI. (1889), pp. 1–8, pl. i. (*Homosteus*).—Ann. Mag. Nat. Hist. [6] vol. ii. (1888), pp. 485–504, pls. xvii. xviii. (Asterolepidæ).

[2] GEOL. MAG. [3] Vol. V. (1888), p. 85.

[3] Rep. U.S. Geol. Surv. Territ., vol. i. pt. i. p. 350, pl. xxxii. fig. 58.

[4] Quart. Journ. Geol. Soc. vol. xliii. (1887), pp. 605-616, pl. xxiii.

[5] GEOL. MAG. [3] Vol. IV. (1887), pp. 248–257, woodcuts.

[6] Palæontographica, vol. xxxv. (1888).

[7] GEOL. MAG. [3] Vol. V. (1888), pp. 512–516.

cerci" had been given in uniform terms, side by side, we venture to think that the illogical nature of their separation would have become apparent. The Chondrostei are said to be destitute of scales and branchiostegal rays, while the Heterocerci are characterized by both these structures well developed; and these are the sole differences of importance recorded. Nevertheless, *Chondrosteus* is termed a Chondrostean, while the fact is omitted that its numerous large branchiostegal rays were described and figured by Egerton thirty years ago; and one of the Chondrosteans mentioned (*Crossopholis*) has the flank-scales even more developed than those of an admitted member of the Palæoniscidæ, *Phanerosteon*. Under such circumstances, Dr. v. Zittel's proposed rearrangement is far from being an emendation of Dr. Traquair's results, and must be regarded as a decidedly retrograde step.

On reaching the Order "Lepidosteidæ," the influence of the author's own researches soon becomes apparent; the Palæontological Museum of Munich containing so large a series of fine Lepidosteoids from the Bavarian Lithographic Stone. Several rearrangements of species are proposed, with one or two new genera; and there are many original figures, drawn from actual specimens, giving much precision to our knowledge of osteological characters. None of the families, however, are named from the typical genera; and in the first division (Stylodontidæ) we observe one genus (*Dictyopyge*), which, if Dinkel's original drawings are correct, contradicts one point in the ordinal definition ("Träger der unpaaren Flossen ebenso zahlreich als die gegliederten Strahlen").

The extreme forms of the Stylodontidæ are *Acentrophorus* and *Tetragonolepis*, and the family also includes *Semionotus*, *Heterolepidotus*, and *Dapedius*. The typical genus of the Sphærodontidæ is *Lepidotus*, with which are identified *Plesiodus*, *Dactylolepis*, and *Scrobodus*; and several interesting figures are given. The Muschelkalk *Colobodus* is also placed here; and likewise the Rhætic *Sargodon*. The so-called Saurodontidæ (*non* Saurodontidæ, Cope) comprise *Eugnathus*, *Platysiagum*, *Ptycholepis*, *Pholidopleurus*, *Pholidophorus*, *Ophiopsis*, *Histionotus*, *Macrosemius*, and other genera; and there is a newly determined form, *Isopholis*, separated from *Pholidophorus* on account of the less vertical elongation of the flank scales and the fact that the ventral scales are scarcely, if at all, broader than deep. There are new figures of the skull and opercular apparatus of *Pholidophorus*, *Isopholis*, and *Macrosemius*; and many species are rearranged. So far as definitions are concerned, this family is not very satisfactorily distinguished from the Stylodontidæ; and we suspect that one genus placed in the latter (*Heterolepidotus*) will ultimately prove identical with one of the present family (*Eugnathus*).

The Rhynchodontidæ are a well-marked family comprising *Aspidorhynchus* and *Belonostomus*; and interesting details are given, partly new. The Liassic *B. acutus* is deferred for consideration under *Belonorhynchus*; and to the comprehensive list of species we would only add *B. laciniatus*, lately recognized from the Chalk of

Mount Lebanon.[1] The Ginglymodi are represented in Europe solely by fragments of *Lepidosteus* from the Eocene and Oligocene; but two extinct genera are recorded from the Lower Tertiary of the United States.

In the order "Amiadæ" are arranged the three families of Microlepidoti, Cyclolepidoti, and Halecomorphi; while *Leptolepis* and *Thrissops* are treated later under the Teleostei. The first family includes *Pachycormus*, *Hypsocormus*, *Sauropsis*, *Agassizia*, and less-known genera. Of the Cyclolepidoti, the typical genus, *Caturus*, is treated at length, with several figures; *Thlattodus*, Owen, is provisionally identified with *Strobilodus*; interesting figures of the vertebræ of *Eurycormus* and *Callopterus* are inserted; and the section concludes with *Oligopleurus*, *Oenoscopus*, *Macrorhipis*, and *Aethalion*. The Halecomorphi comprise the extinct *Megalurus*; and the so-called *Cyclurus*, of the European Tertiaries, is identified with the existing *Amia*.

The order "Pycnodontidæ" is not subdivided into families, and concludes the Ganoidei, with the exception of a brief appendix upon the problematical *Dorypterus*. A new figure of the head of *Gyrodus* is important, and several interesting details are illustrated in separate woodcuts. *Cleithrolepis* is placed with hesitation after *Gyrodus*, and has recently proved to be a Dapedioid.[2] A detailed description of *Microdon* follows, with five figures. *Cœlodus* is made to include most of the so-called species of *Pycnodus* and *Gyrodus* from the Cretaceous; and the genus *Pycnodus* proper is confined to the Eocene.

A new and much improved figure of *Dorypterus* is given; but further specimens are still required before its systematic position can be determined. A. S. W.

(*To be continued.*)

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—Annual General Meeting, February 15, 1889.—Dr. W. T. Blanford, F.R.S., President, in the Chair.

The Secretaries read the Reports of the Council and of the Library and Museum Committee for the year 1888. The Council stated that they had once more to congratulate the Fellows upon the prosperous state of the Society's affairs, although, from various circumstances, there was a considerable falling off in the total number of Fellows. The number elected during the year was 68, and the total accession 54; but owing partly to the results of an inquiry into the list of Fellows whose addresses were unknown, and partly to greater strictness in the application of the Bye-Laws relating to the non-payment of subscriptions, the total loss on the year was much greater than usual, amounting to 97, and thus producing an actual decrease of 43

[1] Geol. Mag. [3] Vol. V. (1888), p. 472.
[2] Quart. Journ. Geol. Soc., vol. xliv. (1888), pp. 141–143, pl. vi. figs. 6, 7.

in the total number of Fellows. The numbers of contributing Fellows was reduced by 8. The Balance-sheet showed receipts to the amount of £2866 16*s.* 10*d.*, and a total expenditure of £2739 16*s.* 1*d.*, including a sum of £159 9*s.* 2*d.* expended in the purchase of stock. The actual excess of receipts over expenditure was £127 0*s.* 9*d.*, and the balance in favour of the Society was £248 12*s.* 5*d.* The Report also mentioned the proceedings taken during the year in connexion with the proposed revision of the Bye-Laws, and briefly noticed the Meeting of the International Geological Congress in London in September. In conclusion it announced the awards of the various Medals and of the proceeds of the Donation Funds in the gift of the Society.

The Report of the Library and Museum Committee, after enumerating the additions made to the Society's Library and Collections during 1888, referred briefly to the work done in the Museum, in the way of cleaning and putting it in order.

In presenting the Wollaston Gold Medal to Prof. T. G. Bonney, D.Sc., F.R.S., the President addressed him as follows:

Professor Bonney,—A Medal that was instituted to promote researches concerning the mineral structure of the earth cannot be more appropriately awarded than for petrological studies. That the method of research has changed since Wollaston's time is largely due to the improvement of modern instruments; the work carried on by yourself and others with the microscope is in direct continuation of that done by Wollaston, his contemporaries and many of his followers with the goniometer, the test-tube, and the balance. In your hands the microscope has been a valuable adjunct to field-observation, and has been chiefly applied to detect the secrets of those rocks which, possessing no organic remains to betray the tale of their origin, have hitherto succeeded in baffling the curiosity of geologists as to their early history. In many parts of the British Islands, throughout the Alps, and in Canada, especially where ancient and obscure formations presented puzzles yet unsolved, you have been occupied in adding to our knowledge. Nor has your attention been confined to Archæan and Plutonic rocks; you were a leader of the opposition to the prevalent, but perhaps somewhat exaggerated view of the powers of glacial erosion, and you have applied the same key that had admitted you to the inner mysteries of metamorphic formations to unlock the history of British sedimentary rocks.

In conferring upon you the chief mark of distinction in its gift, the Council desires to evince its appreciation of your scientific researches, and the Fellows of the Society will, I feel sure, heartily endorse the presentation of the Wollaston Medal to you, who have served so long and so successfully as one of their principal officers.

Prof. Bonney, in reply, said:—Mr. President,—It is difficult for me adequately to express my gratitude to the Council for the great honour which they have conferred upon me, and to you for the terms in which you have spoken of my work. Of this, the defects to myself seem more conspicuous than the merits. I can only plead in excuse for those, that my work has been carried on under many difficulties on which I will not now enlarge. It has been incomplete and preparatory, often destructive rather than constructive, that of a seeker after truths to which another generation will attain. If, indeed, there be any good in it, this is because throughout I have studied nature more than books, I have sought for reasons rather than for authorities, and in so doing have endeavoured to apply the principles of induction which I learnt years ago at Cambridge in the study of mathematics. Still, I am conscious that for this crowning honour I am indebted more to the kindly feeling of others than to my own merits, and can only promise that, if time for scientific work yet remain, I will try to become more worthy of the distinction which has been awarded to me.

In handing the Murchison Medal to Mr. William Topley, F.R.S., for transmission to Professor James Geikie, LL.D., F.R.S., F.G.S., the President addressed him as follows:

Mr. Topley,—The Council has awarded the Murchison Medal to Professor James Geikie in acknowledgment of his important contributions to the Geology of North Britain, and especially of his investigation of glacial phenomena. His 'Great Ice-age' contained a full, careful, and admirably written summary of the observations made up to 1874, and the interest excited by the work was proved by a second edition being required in 1877. Professor Geikie has besides published numerous papers, not the least important of which were two that appeared in the Society's Quarterly Journal containing his observations "On the Glacial Phenomena of the Long Island or Outer Hebrides."

Mr. Topley, in reply, said:—Mr. President.—On behalf of Prof. James Geikie, who is detained in Scotland, I beg most heartily to thank the Council of the Geological Society of London, for the honour conferred upon him in the Award of the Murchison Medal. A prize founded by and continued in honour of his old chief, will, I am sure, have for Prof. James Geikie an especial value. He has desired me to communicate to you the following remarks:—"I feel sure that my fellow-geologists will fully agree with me when I say that the prosecution of our favourite science is its own great reward. The charms that first took our fancy do not lose any of their attractions after we have become confirmed devotees. On the contrary, as years pass, our interest only deepens, and we are so absorbed that happily we escape much of the fret and fever of these bustling times. But a geologist, after all, is human, and he would be less so if he did not warmly appreciate the sympathy of his fellow-hammerers. I need hardly say, therefore, that I am extremely gratified to find that I have gained the sympathy of so representative a body of geologists as the Council of this Society. The distinction which they have been so good as to confer upon me I shall cherish not only as a mark of their appreciation of the little I have done, but as an additional incentive to continued work."

The President then presented the Lyell Medal to Prof. W. Boyd Dawkins, F.R.S., F.G.S., and addressed him as follows:

Professor Boyd Dawkins,—In awarding to you the Lyell Medal for the present year, the Council of the Geological Society wishes to mark its recognition of the importance of your palæontological researches, and especially of the additions made by you to our knowledge of the mammalia found in the later Tertiary and particularly in the Pleistocene deposits of this country. Your researches have extended over a considerable number of years, and amongst the earliest of the papers published by you were those on British fossil oxen and on the dentition of certain extinct species of Rhinoceros, all of which appeared in the Society's Quarterly Journal. Your attention has especially been directed to primæval man, his implements, and the mammals that were his contemporaries, and in your works on 'Cave Hunting' and 'Early Man in Britain' you have done much to disseminate a knowledge of scientific discoveries amongst readers whom more technical works would have repelled.

Prof. Boyd Dawkins, in reply, said:—Mr. President.—I thank you, from my heart, for the kind words which you have spoken in awarding to me the honour of the Lyell Medal. I feel, Sir, on looking back on the work of the last 25 years, how little I have been able to do compared with what I proposed to do, and I console myself with the knowledge that this is the common experience of all workers in all subjects. My main work has been in that field of Geological inquiry which looks towards history, in which Sir Charles Lyell, the founder of the Medal, rejoiced to labour, and its results have for the most part been published in the Journal of this Society. I feel therefore peculiar gratification in receiving in the name of this Society this medal for work done in Sir Charles Lyell's favourite field. If I may speak of the future, I would say that I shall work all the harder through this mark of approbation of the Society, and that I hope to be able to do a little, in the time that is left to me, to fill up the blank which lies between our science and history.

In presenting the Bigsby Medal to Mr. J. J. Harris Teall, F.G.S., the President said:

Mr. Teall,—Your contributions to the Petrology of the British Islands have had a great influence on the views of British geologists. In your papers on the dykes of Northern England and Scotland you have added much to our previous knowledge, and in your description of the metamorphosis of dolerite into hornblende-schist you succeeded in proving what had certainly been suspected, but probably never so clearly

demonstrated before, the production of foliated rocks by the action of mechanical forces on igneous formations. Your 'British Petrography,' the concluding part of which has recently appeared, contains many original observations, and well maintains the scientific character of your previous writings, whilst it supplies a much-needed desideratum to the geologists of this country. The Council of this Society, whilst awarding to you the Bigsby Medal in token of the esteem in which they hold your work, hope your 'British Petrography' may be the precursor of other equally valuable additions to our science.

Mr. Teall, in reply, said:—I beg to offer my sincere thanks to the Council for the honour they have conferred upon me, and to you, Sir, for the kind way in which you have referred to my work. There is an accidental circumstance which adds to the pleasure I feel on this occasion; it is that I receive the Bigsby Medal on the day that my earliest instructor receives the highest award which this Society can give. I should not be standing here to-day if it had not been my good fortune to come in contact with Prof. Bonney at Cambridge.

The President next presented to Mr. A. Smith Woodward, F.G.S., the Balance of the Proceeds of the Wollaston Fund, and said:

Mr. Smith Woodward,—In presenting to you the Balance of the Wollaston Fund, the Council of the Geological Society recognize the value of your contributions to the knowledge of fossil fishes and fossil reptiles. Your publications on these classes of animals are carefully written, and show an extensive acquaintance with the rather intricate literature of the subject. I hope that the award now handed to you will be an incentive to further researches and an assistance in prosecuting them.

Mr. Smith-Woodward, in reply, said:—Mr. President,—I beg to express my best thanks to the Council of the Geological Society for the honour they have done me in making this award, and also to yourself, Sir, for the kind manner in which you have spoken of my slight attempts to extend the boundaries of one small department of our Science. It has always been my greatest pleasure to devote my leisure hours to the study of Natural History; and it is very gratifying to feel that the circumstances of the last few years have enabled me to follow these pursuits in a manner that is deemed worthy of recognition by this Society. Continual access to a collection like that of the British Museum affords exceptional facilities for palæontological research; and the experience gained when assisting my late senior colleague, Mr. William Davies, in the arrangement of the unique series of Fossil Fishes, has pointed out to me a wide field for investigation among the lower extinct Vertebrates. The highly-valued encouragement received to-day will incite me to renewed efforts, and I shall still strive to make the best use of the advantages resulting from my official position.

In presenting the Balance of the Murchison Geological Fund to Mr. Grenville A. J. Cole, F.G.S., the President said:

Mr. Grenville Cole,—In the course of the last few years you have published several interesting papers on petrological subjects, and especially on spherulitic and perlitic structure, and on volcanic glasses. The Council of the Geological Society has presented you with the Balance of the Murchison Fund in recognition of your contributions to Petrology, and as a means of aiding you in extending your investigations.

Mr. Cole, in reply, said:—Mr. President,—This award, granted by the Council of the Geological Society, is all the more pleasant to me because so completely unexpected. It is to me but another evidence of the generous encouragement that is extended by the master-craftsmen to the apprentices in geological work. To deal with rocks from a purely mineralogical standpoint would be to ignore the broad principles of geology marked out by the founders of the science, and it will always be my earnest endeavour, stimulated by the fellowship of this Society, to connect the minuter researches of the laboratory with the study of earth-structure in the field.

The President lastly presented to M. Louis Dollo the Balance of the Proceeds of the Lyell Geological Fund, and addressed him as follows:

M. Dollo,—The Reptilian and Batrachian Faunas of the Upper Secondary and the Tertiary strata of Belgium have only of late years become generally known to geologists. That the scientific world is now better informed concerning the wonderful remains of Cretaceous Dinosaurs, Mosasaurs, and Crocodiles, and both Cretaceous and Tertiary Chelonia from the Belgian beds is in great part due to your descriptions. In awarding to you the Balance of the Lyell Fund the Council of the Geological Society hope to aid you in prosecuting further researches.

M. Dollo, in reply, said:—Mr. President,—I beg to express my acknowledgments for the honour which has been bestowed upon me by the Geological Society. This encouragement will stimulate my energies in the field of palæontology, and my greatest and sincere desire is that I may, on any occasion, render myself useful to the Geological Society of London, and fully deserving of the favour which it has been pleased to confer upon me. The nature of the researches to which I have devoted these last years has afforded me the advantage of frequent intercourse with many of the palæontologists in this country; and I wish on this occasion to express to them my indebtedness for the many encouragements I have received.

The President then read his Anniversary Address, in which, after giving obituary notices of Mr. W. Hellier Baily, Prof. H. Carvill Lewis, Vice-Admiral T. A. B. Spratt, Viscount Eversley, Mr. John Brown, Mr. W. Ogilby, and other deceased Fellows, together with notices of the Foreign Members and Correspondents of the Society who have died since the last Anniversary Meeting (Prof. Gerhard Vom Rath, Prof. T. Kjerulf, Prof. Giuseppe Meneghini, and Prof. Giuseppe Seguenza), he noticed the papers which had been published by the Society during the past year. The remainder of the Address consisted chiefly of a discussion of the work of the International Congress from its commencement to the last Meeting in London in 1888, and dwelt upon the influence which such meetings exercise upon the progress of geological science, quite apart from any formal resolutions which may be arrived at by the Members.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President:* W. T. Blanford, LL.D., F.R.S. *Vice-Presidents:* John Evans, D.C.L., LL.D., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. J. W. Judd, F.R.S.; Prof. J. Prestwich, M.A., F.R.S. *Secretaries:* W. H. Hudleston, Esq., M.A., F.R.S.; J. E. Marr, Esq., M.A. *Foreign Secretary:* Sir Warington W. Smyth, M.A., F.R.S. *Treasurer:* Prof. T. Wiltshire, M.A., F.L.S. *Council:* Prof. J. F. Blake, M.A.; W. T. Blanford, LL.D., F.R.S.; Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.; James Carter, Esq.; John Evans, D.C.L., LL.D., F.R.S.; L. Fletcher, Esq., M.A.; A. Geikie, LL.D., F.R.S.; Prof. A. H. Green, M.A., F.R.S.; Rev. Edwin Hill, M.A.; W. H. Hudleston, Esq., M.A., F.R.S.; Prof. T. M'Kenny Hughes, M.A.; Prof. J. W. Judd, F.R.S.; Major-Gen. C. A. McMahon; J. E. Marr, Esq., M.A.; E. T. Newton, Esq.; Prof. J. Prestwich, M.A., F.R.S.; F. W. Rudler, Esq.; Prof. H. G. Seeley, F.R.S.; Sir Warington W. Smyth, M.A., F.R.S.; W. Topley, Esq., F.R.S.; Rev. G. F. Whidborne, M.A.; Prof. T. Wiltshire, M.A., F.L.S.; Rev. H. H. Winwood, M.A.

II.—February 20, 1889.—W. T. Blanford, LL.D., F.R.S., President, in the Chair.—The following communications were read:

1. "On the Cotteswold, Midford, and Yeovil Sands, and the division between Lias and Oolite." By S. S. Buckman, Esq., F.G.S.

After giving a short sketch of the work and opinions of other writers, the author proceeded with the evidence on which his own views are based. He described a series of sections of the typical exposures of "Sands" and contiguous strata, commencing near Stroud and terminating on the Dorset coast. Dividing the series

into *seven* horizons, characterized by their distinctive Ammonites, viz. *Amm. communis*, *variabilis*, *striatulus*, *dispansus*, the genus *Dumortieria*, *Amm. Moorei* and *opalinus*, and taking the *striatulus*-beds as a fixed starting-point, the author demonstrated how the strata varied in regard to that horizon. The Cotteswold Sands, containing the *variabilis*- and part of the *communis*-horizons, were below the *striatulus*-beds; the Midford Sands, containing the *dispansus*-horizon, were above. *Gramm. striatulum* occupying a thin bed at the base; the Yeovil Sands, containing the *Moorei*- and *Dumortieria*-horizon, and were consequently still later deposits.

Since the different sands were deposited not on a horizontal plane, in point of time, but, as it were, obliquely, the deposit of Cotteswold Sands having ceased before that of Yeovil Sands commenced, it was incorrect to lump all the "Sands" from the Cotteswolds to the Dorset coast under the single local name "Midford Sands," thereby implying a contemporaneity which did not exist, while the use of the present restricted local names was defended.

The Ammonites were apparently uninfluenced by changes in the character of the deposit, since the same species are found in Limestone in the Cotteswolds, in Sands at Midford, and in argillaceous Marl at Ilminster. The change from argillaceous to arenaceous or calcareous deposits has been looked upon as so distinct a feature, that it has been utilized as a great argument in favour of drawing the line between Lias and Oolite at that point; but if this be done, the line is always drawn at different horizons in different districts.

If lithology furnishes no reason for a dividing-line at this point, it was shown that neither did palæontology. It was also shown that the Ammonite family Hilderoceratidæ dominated the period from the *Falcifer*- to the *Concavus*-zones, and that with the close of the latter zone they died out with singular abruptness, and that, furthermore, there exists, both in England and upon the continent, a marked hiatus at the same point due to the absence of a zone or a number of zones.

On account of these facts the proposal was put forward that d'Orbigny's term "Toarcien" should be employed to designate the strata from the *Falcifer*-zone to the *Concavus*-zone inclusive, that this term should not be used in the sense of merely an extended "Upper Lias," but to mark an entirely distinct transition-formation,—a definite part of the Jurassic period,—separating the typical Lias from the mass of thoroughly Oolitic strata.

2. "On some Nodular Felstones of the Lleyn Peninsula." By Miss Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

This paper dealt with two small masses of rock forming the headlands of Pen-y-chain and Careg-y-defaid, a few miles from Pwellheli. They consist of old lava-flows, once glassy, now devitrified and, at the former place, associated with interbedded agglomeratic and ashy strata. The lithological characters, as well as other slight evidence obtained, would fully support the identification by the Survey of the surrounding beds as of Bala age.

The rocks exhibit evidence of alteration and of silicification, suggesting that the district may have passed through a Solfatara stage, and that its condition may have been not far removed from that of a geyser region. Perlitic structure is common, and is often found in connection with spherulitic growth, of which there are many gradations, and specially marked and large examples are presented in the agate nodules.

Some nodules seem to result from spheroidal fracture, others to be masses of flow-brecciation; but the majority have a spherulitic crust, often surrounding an interior occupied by secondary quartz or chalcedony. Similar specimens were described and compared, which had been received from Boulay Bay, through the kindness of Professor Bonney. The evidence of these and of the Lleyn examples appears to be strongly in favour of the view that the spherulite is the least altered and most durable part of the mass. Other considerations were brought forward by the author, which would offer some further difficulties in accepting the decomposition-theory to account for the origin of the interior of the nodules. Some of the specimens described present certain special characteristics, and, at one locality in the Lleyn, what seem to be quartzose amygdaloids occur, in close relation to agate nodules. On the whole, although the mode of origin is difficult or impossible definitely to prove, the evidence appears to suggest that in these nodules a spherulitic crust has formed around an originally vesicular nucleus.

3. "On the Action of Pure Water, and of Water saturated with Carbonic-acid Gas, on the Minerals of the Mica Family." By Alexander Johnstone, Esq., F.G.S.

Two muscovite fragments were suspended for a year, one in distilled water, the other in water saturated with carbonic anhydride. A good deal of mica-dust was detached from each, but no material had been dissolved, the only chemical change being hydration, accompanied by physical alteration, producing a mineral chemically and physically similar to a natural hydromuscovite.

When biotite was similarly treated, the mineral suspended in the distilled water became a hydrobiotite, whilst that in the water saturated with carbonic anhydride underwent chemical change, and was converted into hydromuscovite by loss of magnesia and iron, which were dissolved in the water.

Lepidomelane in pure water became hydrated, but in carbonated water also sustained a loss of iron.

The author has ascertained that when anhydrous micas become hydrated, or lower hydrated ones more highly hydrated, they increase in bulk.

Royal Geological Society of Ireland.

THE Annual General Meeting for the election of officers took place at the rooms of the Royal Dublin Society on the 20th of February. Mr. A. B. Wynne, F.G.S., was elected President and addressed the meeting, taking two of the most important questions recently brought under the notice of geologists, as his subject,

namely, the evidences of enormous earth-movements and horizontal displacement in the Highlands. And secondly the arguments in support of a Palæozoic, or Carboniferous to Permian, Glacial period. With regard to the former, the revelations announced by the officers of the Geological Survey as to transplacement, metamorphism, and deformation of the rocks, were brought to notice, and amongst theoretical or other observations bearing upon the question of how the rock-masses were afforded room to move, the late observations by Dr. Ricketts in the GEOLOGICAL MAGAZINE were referred to; also Mr. J. R. Kilroe's suggestions, which would go far to afford a solution of the question. These suggestions, now for the first time advanced, indicated that where areas of locally reduced vertical pressure came into existence, by bulging of the crust, in consequence of contraction in cooling or other cause, the greater vertical pressure on each side of such an area (possibly increased by the deposition of denuded materials from the elevated part) would produce attenuation of the underlying rocks. The pressed-out substance of these flowing —after the manner described by Tresca and Daubrée—towards the space beneath the area of least pressure, crumpling and folding of beds, in this position, would result. This need not necessarily be accompanied in such situations by metamorphism, but beneath regions of extreme superincumbent pressure, once the cosmical equilibrium was disturbed and motion originated, metamorphism would proceed actively till equilibrium was restored. Repeated action of this kind would produce alternating zones of greater or less, or no, metamorphism, and where the vertical pressure and consequent movement on each side of an elevated area of least pressure differed in amount, the tangential thrust of the rock-masses, moving in opposite directions towards each other, would vary, the most powerful thrust tending to pass over the other with a more and less upward inclination towards the place of least pressure and least resistance at the surface of the elevated area. Development of these actions where the scene of the elevation had changed to a previously altered region, would account for most of the phenomena which form the key to the latest published interpretations of Highland geology.

Regarding the second subject, the address pointed out that since the time when the Rev. Dr. Haughton recorded, thirty-eight years ago, the occurrence of glacial boulders of granite in the Carboniferous limestone of Dublin, a great number of writers, including Dr. Blanford, President of the Geological Society of London, had advocated the existence of glacial features in connexion with Permian or Carboniferous boulder-beds. Amongst these writers was Sir A. C. Ramsay, who recognized first the glacial character of certain Permian deposits in England, but numerous other writers had maintained the same character for beds in India, Afghanistan, South Africa and East Australia, regions supposed to have been once united by Sclater and Haeckel's lost continent of 'Lemuria.' Attention was called to the latest contribution to the geological literature of the subject by Dr. Waagen of Prague, who contends that the ancient Carboniferous Ice Age prevailed over the whole earth except South America, and

the evidence for his deductions was discussed, it being thought improbable that these would be at once or entirely accepted. The expanding field of geological investigation as the science progressed, was alluded to, fresh and important discoveries ever rewarding those who laboured to complete the history of the earth.

A vote of thanks for the Address was proposed by Dr. Hull and seconded by the Rev. Dr. Haughton, who observed that for thirty years he had taught the geology of the past, and now contemplating the geology of the present, he shrunk from conjecturing what might be that of the future. He was glad to find the discoveries of the late Prof. Tresca, of Turin, as to viscous fluidity from pressure, occurring in the case of solids and metals like silver, lead and gold, applied in explanation of geological structure. And in this connexion he was reminded of the deposit of gypsum cut through in forming the St. Gothard tunnel, which under great pressure flowed into the tunnel and stopped the works. The Carboniferous Ice-age possessed considerable interest to him from his having been the first to record glacial boulders of that period. He was much pleased with the Address and felicitated the Society upon the election which had taken place.

CORRESPONDENCE.

DYKE IN THE LIZARD SERPENTINE.[1]

Sir,—In reference to Mr. Somervail's answer (last month) to my letter indicating two inaccuracies in his article on a dyke in the Lizard Serpentine, permit me to state that I did not mistake the south for the north end of Pentreath Beach, or the locality of which he wrote. It is not my custom to criticise without using all pains to ascertain what an author has said or (if possible) what he means. As to this dyke, I believe (though to be quite sure I should have to revisit the locality) that in my diary I have a sketch of and a note on part of it; but at any rate I know its situation. On the theoretical and hypothetical views put forward in the article and the letter I do not presume to comment. Mr. Somervail has doubtless discovered some quicker and surer way to a conclusion than the laborious route on which I have been obliged to plod.

23, Denning Road, Hampstead, N.W., *February* 2, 1889. T. G. Bonney.

SCIENTIFIC BIBLIOGRAPHY.[1]

Sir,—All workers will most cordially endorse the remarks of Mr. S. S. Buckman (Geol. Mag. N.S. Dec. III. Vol. VI. No. II. p. 94. London, Feb. 1889). But surely the Societies are not to blame for sins of omission in "Authors' Copies." It is always open to the author of a paper, when ordering his separate copies, to order at the same time a title-page or printed cover which shall give all necessary details. It is not to the advantage of a Society to permit an author to issue his paper as though it were an independent publication:

[1] The Editor regrets that Prof. Bonney's and Mr. Bather's letters were omitted from the last number of the Magazine from want of space.—Edit. G.M.

this however is the effect produced when no reference to the Society is made when the pagination is altered, and the type partially reset. All parties would be benefited if the Society would prohibit such unnecessary and confusing changes. But there is no inducement to a Society to consult the wishes of those who break up odd volumes of their Proceedings, while a careful worker or a good bookseller will take care to copy the information before the original covers are destroyed. Should public-spirit ever lead a Society to move in this matter in the direction of convenience to specialists, then the suggestions of Mr. Buckman would be admirable. One might further suggest that a fresh paper should always begin on a fresh leaf; the extra expense would be small, the convenience to book-breakers great. In some German and American magazines each paper begins a fresh "Section": so excellent an arrangement might well be adopted by our leading Societies.

As to authors, they would further benefit their readers by attention to two points. First, by giving definite and descriptive instead of vague and unsatisfying titles to their papers. Secondly, by publishing some address at which letters or papers would find them: one often wishes to communicate with a fellow-worker in one's special field, but is deterred by the absence of any information as to his whereabouts, and one often hesitates to make the hardworked Editor a general postman. The chief gainers by this would, however, be the authors themselves.

In referring to a paper it is very advisable to give its title, as well as that of the publication in which it appeared: for the possessors of a separate copy are often unable to recognize it when merely referred to by a string of letters and figures, especially when the proper information has not been given with the authors' copies.

Brit. Mus. (Nat. Hist.), S.W. F. A. Bather.

THE OLENELLUS ZONE IN N. W. EUROPE.

Sir,—It has been pointed out to me that the original discovery of the *Olenellus zone* on the European side of the Atlantic was not made by the late Dr. Linnarsson, as indicated in my recent "*Note on the Discovery of the Olenellus Fauna in Britain*,"[1] but was the work of my friend Dr. A. G. Nathorst, of Stockholm. In the year 1868 Dr. Nathorst detected and described a new and distinct horizon below the "*Paradoxides Beds*" at Andrarum (Scania), containing annelide trails and examples of *Lingula*.[2] In the following year he discovered in the same horizon a *Paradoxides-like* form, together with examples of *Ellipsocephalus*, and a species of *Arionellus*. Dr. Torell, to whom he communicated this discovery, gave the *Paradoxides*-form the provisional title of "*Paradoxides Wahlenbergi*," and named the containing beds the "*Paradoxides Wahlenbergi strata*;"[3] but he did not describe or figure the new form.

Linnarsson made his own discovery of *Olenellus* (*Paradoxides*)

[1] Geol. Mag., Nov. 1888. p. 484.

[2] Öfvers. Kongl. Vetens. Akad. Förhandlinger, Stockholm, 1869, p. 64.

[3] Torell, Petrefacta suecana Formationis Cambrica, 1869–70.

Kjerulfi in Norway in 1870. He published an account of this discovery in 1871, naming the characteristic Trilobite *Paradoxides Kjerulfi*,[1] and figuring it. The identity of this species with the previously named *Paradoxides Wahlenbergi* of Dr. Torell was distinctly acknowledged by Linnarsson in the year 1876.[2] Thus, while it must be admitted that Linnarsson's specific title of *Paradoxides (Olenellus) Kjerulfi* must be retained as that of the first Trilobite *figured* and described from the *Olenellus Zone* in Europe; yet the actual credit of the original detection of this *Olenellus* zone belongs unquestionably to Dr. Nathorst, who made known its stratigraphical position in Sweden at least two years before Linnarsson detected and described the species of the *Olenellus* zone from Norway.

CHAS. LAPWORTH.

A WOODEN DINOSAUR.[3]

SIR,—Frequent protests have been entered against the hastiness with which new species or even genera are founded upon fragmentary materials. But all previous blunders in this line are thrown into the shade by the recent restoration of a new genus of Dinosaurs, *Aachenosaurus*, from two fragments which, on microscopical examination, prove to be nothing but masses of silicified wood. The contributions to this subject, quoted below, not being easily procurable, we think the readers of this Journal may be interested by the following analysis.

In two notes published in Belgium, Abbé G. Smets describes a fossil obtained by him from the sands of Aix-la-Chapelle, in a quarry at Moresnet, Belgium, between Verviers and Aix-la-Chapelle, sands in which, according to the most competent local authorities, no vertebrate remains have as yet come to light. This fossil has been described as a portion of the right dentary bone, "to which joins another fragment, very probably of the coronoid," of a new Dinosaur of the family Hadrosauridæ. The author declared he had tested the bony nature of this fossil by means of the lens and the microscope, without, however, making any sections; while some incrustations were identified by him as teeth. A plate, so rudely executed as to be utterly worthless, accompanies his second paper, which concludes with an attempt at a restoration of this marvellous Dinosaur, which is supposed to have been biped, to have attained a length of 4 to 5 metres, to have been provided with a spatulate mandible, to have fed on succulent plants, while its hide was probably furnished with an armour of dermal spines.

M. Dollo having obtained leave to examine and make micro-

[1] Linnarsson, Öfvers. af Kongl. Vetens. Akad. Förhand. 1871, p. 784.

[2] *Ibid*, Brachiopoda of Swedish Paradoxides beds. Bihang. Kong. Swensk. Vet. Akad. Handlingar. 1876, p. 5.

[3] G. SMETS. Un Reptile nouveau des Sables d'Aix-la-Chapelle. Muséon (Louvain), vi. 1887, pp. 133, *et seq.*

G. SMETS. *Aachenosaurus multidens*, Reptile fossile des Sables d'Aix-la-Chapelle (Mémoire présenté au congrès des savants catholiques à Paris et lu dans la séance du 9 avril, 1888). Hasselt, 1888, 8vo. 23 pp., 1 pl.

L. DOLLO. *Aachenosaurus multidens*, Bull. Soc. Belge Géol. ii. 1888, p. 300.

G. SMETS. Un mot de réponse à M. L. Dollo. Hasselt, 1889, 8vo. 15 pp.

scopical sections of the fragments, has come to the conclusion that they are merely masses of fossil wood, a view in which he is supported by a well-known botanist, Dr. M. Hovelacque.

This demolishing of the new Dinosaur has brought upon M. Dollo a would-be crushing retort from its founder. The tone of the reply is, however, not of a kind to raise its author in the opinion of the scientific, or, indeed, for that matter, of any other world. He seems indeed to have followed the Old Bailey maxim, that when you have no case, the only thing left is to abuse the plaintiff and all connected with him. We were, however, especially concerned to find our own names dragged into this unseemly controversy, on the ground that we have seen reason to differ in certain respects from M. Dollo's views as to the serial position or specific distinction of some of the Wealden Reptiles of Belgium. To make such differences of opinion the grounds of a deliberate impeachment of M. Dollo's capacity as a palæontologist is, on the face of it, too absurd for serious notice. We believe, indeed, that scarcely any two palæontologists can be found who will agree with one another in all respects as to the affinity of a totally extinct type of animal; and when the type specimens are in the fragmentary condition in which some of the allied English forms were found, there is no wonder that M. Dollo failed to recognize their identity or kinship with the Belgian examples. In one instance, indeed, one of the undersigned has since agreed with M. Dollo in regarding the Belgian Crocodile *Bernissartia* as generically distinct from the English *Hylæochampsa*.

We are well assured, in conclusion, that no words of ours are needed to express the high estimation in which M. Dollo's palæontological work is held, not only in this country, but wherever the science is cultivated; and we look forward with keen hope to the appearance of fully illustrated monographs from his hand, which will worthily proclaim to the world the priceless treasures preserved in the Brussels Museum.

G. A. Boulenger,
R. Lydekker.

British Museum, 20 *March*, 1889.

MISCELLANEOUS.

Human Relics and Bones of Mastodon found in Association.—Mr. J. M. Clarke reports to Dr. James Hall, State-Geologist, Albany, N.Y., that in the village of Attica, Wyoming Co., N.Y., some bones of Mastodon (or possibly Elephant) and of Elk (?), together with charcoal, have been found at a depth of about six feet, in a natural sink-hole or bog-hole in the shale of that place; and that some ancient pottery and charcoal were found in a neighbouring bog-hole, about 40 feet distant, and at a depth of a foot lower than in the other pit. The two holes or pits were once connected by a small watercourse. The hole with the bones and charcoal was at top about 30 feet, and that with the pottery and charcoal about 75 feet in diameter. Both narrowed downwards, and contained "black muck and mucky clay"; one is under the street and the other in a pasture.

T. R. J.